DECEMBER 1958

Journal

AMERICAN WATER WORKS ASSOCIATION

VOL. 50 • NO. 12

The Xmas tree is all wet—all water, in fact —in water main tunnel at Toronto

In this issue:

AWWA CERTIFICATION PROGRAM
Howson, Policy Statement

CHEMICAL DISTRIBUTION SYSTEMS
Langworthy

SYNDETS IN GROUND WATER
Flynn, Andreoli, Guerrera

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AASGP Committee Report

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UNDERGROUND CORROSION
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BACKFLOW PREVENTERS
Joint Committee Report

TORONTO DISTRIBUTION SYSTEM
Clark

CONFERENCE AND SECTION PROGRAMS
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San Francisco, July 12–17

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Coming Meetings

AWWA SECTIONS

Winter-Spring 1959

Jan. 27—New York Section, Mid-winter Luncheon Meeting, at Park Sheraton Hotel, New York. Secretary, Kimball Blanchard, 2222 Jackson Ave., Long Island City 1.

Feb. 4–6—Indiana Section, at Sheraton-French Lick Hotel, French Lick. Secretary, Chester H. Canham, State Board of Health, 1330 W. Michigan St., Indianapolis 7.

Mar. 11–13—Illinois Section, at Morrison Hotel, Chicago. Secretary, Dewey W. Johnson, Research Engr., Cast Iron Pipe Research Assn., 3440 Prudential Plaza, Chicago 1.

Mar. 19—New England Section, at Statler Hotel, Boston, Mass. Secretary, J. E. Revelle, Dist. Sales Mgr., Chicago Bridge & Iron Co., 201 Devonshire St., Boston 10, Mass.

Apr. 5–8—Southeastern Section, at Wade Hampton Hotel, Columbia, S.C. Secretary, N. M. deJarnette, Engr., Water Quality Div., State Dept. of Public Health, 309 State Office Bldg., Atlanta 3, Ga.

Apr. 8–10—New York Section, at Powers Hotel, Rochester. Secretary, Kimball Blanchard, New York Branch Sales Office, Neptune Meter Co., 2222 Jackson Ave., Long Island City 1.

Apr. 9–11—Montana Section, at Jordan Hotel, Glendive. Secretary, Arthur W. Clarkson, Asst. Director, Div. of Environmental Sanitation, State Board of Health, Helena.

Apr. 15–17—Nebraska Section, at Cornhusker Hotel, Lincoln. Secretary, Rupert C. Ott Jr., Repr., Neptune Meter Co., 2818—21st St., Columbus.

Apr. 16–18—Arizona Section, at Hi-Way House Hotel, Phoenix. Secretary, Stanford I. Roth, Supvr. of Water Collections, Div. of Water & Sewers, Phoenix.

Apr. 22–24—Kansas Section, at Baker Hotel, Hutchinson. Secretary, Harry W. Badley, Repr., Neptune Meter Co., 119 W. Cloud, Salina.

Apr. 23–25—Pacific Northwest Section, at Vancouver Hotel, Vancouver, B.C. Secretary, Fred D. Jones, W. 2108 Maxwell Ave., Spokane 11, Wash.

(Continued on page 8)

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Coming Meetings

(Continued from page 6)

May 3–6—Canadian Section, at Queen Elizabeth Hotel, Montreal, Que. Secretary, A. E. Berry, Gen. Mgr. & Chief Engr., Ontario Water Resources Com., Parliament Bldgs., Toronto, Ont.

Fall 1959

Sep. 9–11—Wisconsin Section, at Hotel Schroeder, Milwaukee. Secretary, Harry Breimeister, Chief Utilities Engr., City Engineer's Office, City Hall, Milwaukee.

Sep. 14–16—Kentucky-Tennessee Section, at Lafayette Hotel, Lexington, Ky. Secretary, J. Wiley Finney Jr., Howard K. Bell, Cons. Engrs., 553 S. Limestone St., Lexington, Ky.

Sep. 16–18—New York Section, at Saranac Inn, Upper Saranac Lake. Secretary, Kimball Blanchard, Neptune Meter Co., New York Branch Sales Office, 2222 Jackson Ave., Long Island City.

Sep. 23–25—Michigan Section, at Bancroft Hotel, Saginaw. Secretary, T. L. Vander Velde, Chief, Section of Water Supply, State Dept. of Health, DeWitt Rd., Lansing.

Sep. 27–29—Missouri Section, at President Hotel, Kansas City. Secretary, Warren A. Kramer, Chief, Water Supply, Div. of Health, State Office Building, Jefferson City.

Oct. 7–9—Chesapeake Section (location to be decided). Secretary, Carl J. Lauter, 6955—33rd St., N.W., Washington, D.C.

Oct. 14–16—Iowa Section, at Fort Des Moines Hotel, Des Moines. Secretary, J. J. Hail, Supt., Water Dept., City Hall, Dubuque.

Oct. 18–21—Alabama-Mississippi Section (with Southwest Section) at Roosevelt Hotel, New Orleans, La. Secretary, Ernest Bryan, Southern Sales Mgr., McWane Cast Iron Pipe Co., Box 2601, Birmingham, Ala.

Oct. 18–21—Southwest Section (with Alabama-Mississippi Section) at Roosevelt Hotel, New Orleans, La. Secretary, L. A. Jackson, Mgr.-Engr., Municipal Water Works, Robinson Memorial Auditorium, Little Rock, Ark.

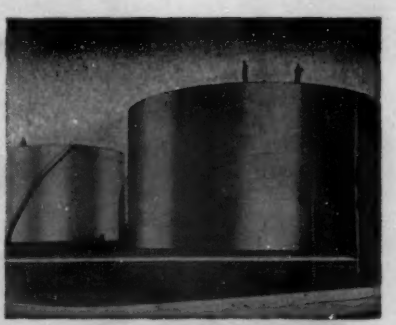
Oct. 28–29—West Virginia Section, Parkersburg. Secretary, Hugh W. Hetzer, Engr., Union Carbide Chemical Co., Box 8361, South Charleston.

Oct. 28–30—Ohio Section, at Biltmore Hotel, Dayton. Secretary, J. Howard Bass, Robt. F. McGivern & Assocs., 1771 W. 5th Ave., Columbus.

Oct. 30—California Section (Business Meeting) at Hacienda Hotel, Bakersfield. Secretary, Roy E. Dodson Jr., Supt. of Production, San Diego Water Dept., Balboa Park, San Diego.

Nov. 4–6—Virginia Section, at Hotel Roanoke, Roanoke. Secretary, J. P. Kavanaugh, Dist. Mgr., Wallace & Tiernan Inc., 213 Carlton Terrace Bldg., Roanoke.

Nov. 9–11—North Carolina Section, at O. Henry Hotel, Greensboro. Secretary, D. Y. Brannock, Supt., Water & Sewage Plants, Burlington.



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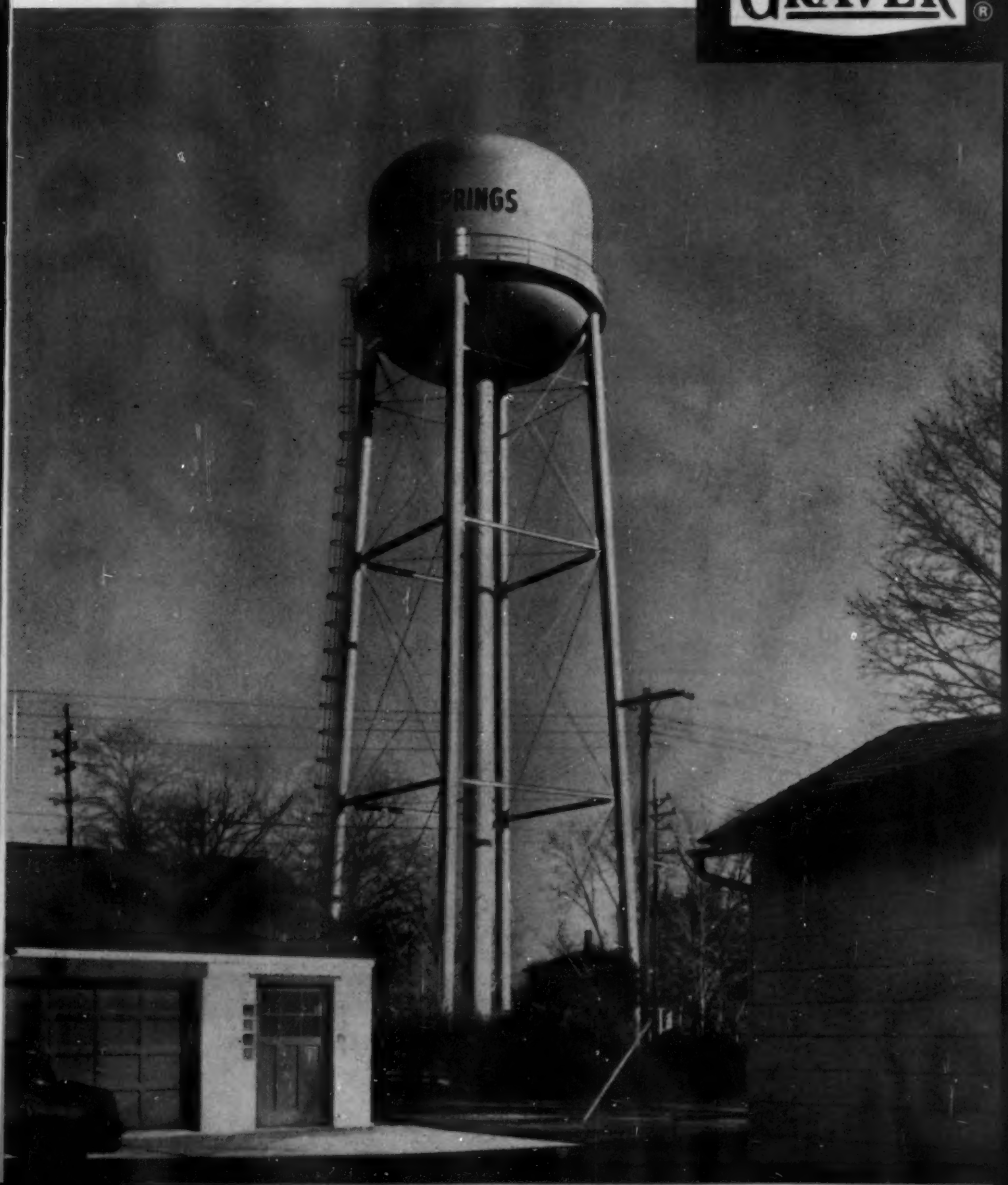

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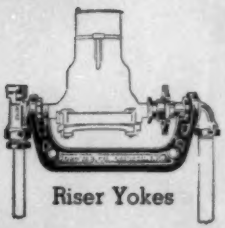

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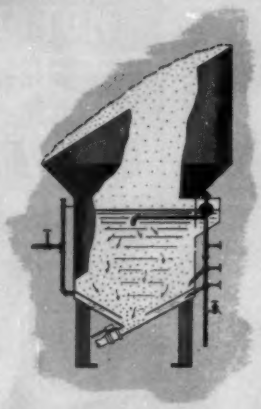
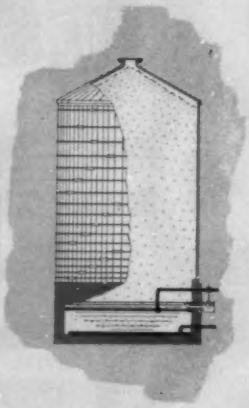
THE FORD METER BOX COMPANY, INC. Wabash, Indiana

BRINE PRODUCTION

How it can affect design of water softening installations

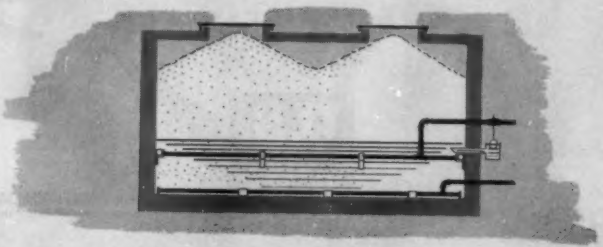


The capacity and location of a rock-salt dissolver strongly influence plant design. If a large dissolver is needed, but space is limited—underground construction may be most economical. Or perhaps the dissolver should be designed as a tall, space-saving silo. Whatever the unit chosen, however, provision should be made for easy delivery of rock salt, and for such routine maintenance as periodic dissolver cleanout.



Design problems such as these have assumed added importance with the large salt tonnages required in today's water softening installations. That's why treatment plant designers and builders are turning more frequently to International Salt Company. With over 50 years of experience and continuing research in all phases of salt handling and brine production, International can suggest many new and practical ideas in connection with salt purchase, storage and dissolving for regenerating ion exchangers. This service costs you nothing.

Service and research are the extras in STERLING SALT



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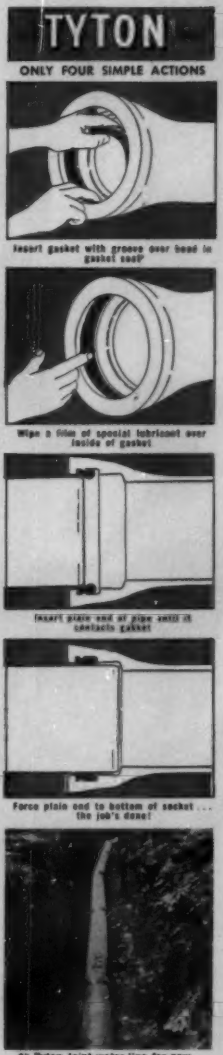
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ONLY FOUR SIMPLE ACTIONS
Insert gasket with groove over bead in gasket seat
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Force plain end to bottom of socket ... the job's done!
8" Tyton Joint water line for new high school in Alabama.

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"This filter bottom needs no maintenance, even after 5 years of operation"

"Our plant was built originally to handle 8 MGD, with conventional perforated cast iron laterals, and 18" of graded gravel supporting 30" of sand. Back in 1953 we installed these ALOXITE® aluminum oxide porous plates to get rid of the problem of shifting gravel layers. By 1955, the results had proved to be so good that we've been adding more porous bottoms every year.

"For one thing, we don't have to worry now about gravel beds being upset, or cleaning out mudballs. It's also very easy to move away the sand above ALOXITE plates so we can inspect the hold-down bolts or any part of the bottoms. It's easy to clean the filter, too. We use a minimum of washwater, and of course there's no more mixing of graded gravel and sand.

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"Finally, these ALOXITE filters were the least expensive and most easily installed type of bottom for our existing structure. We were very careful about the installation — and this care has paid dividends in the excellent condition of the porous plates, the hold-down bolts, and the joints between the plates."

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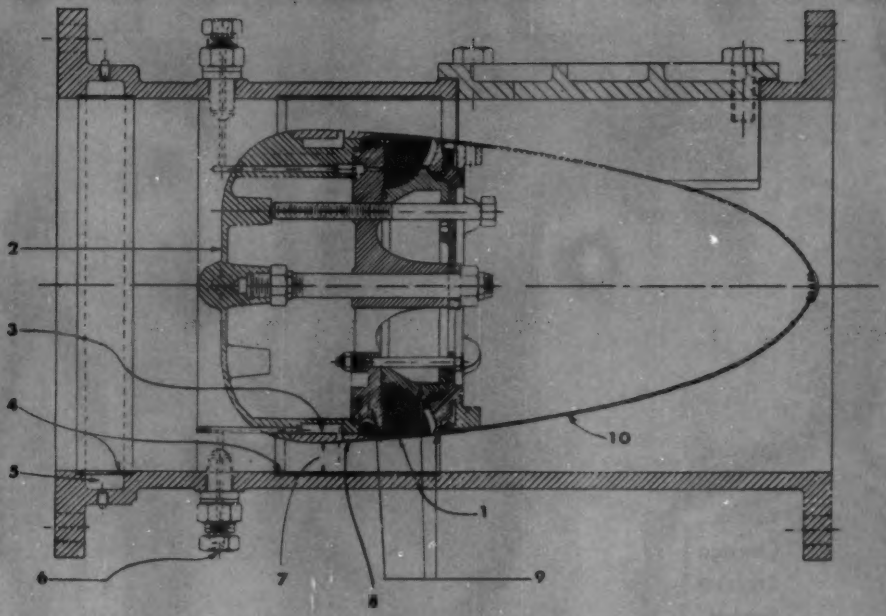

1. Only moving part is this modulator.
2. Nose piece.
3. Multi-piezometer low-pressure chamber.
4. Housing liner.
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6. Low-pressure connection.
7. Annular throat.
8. Throat ring.
9. Modulair assembly—clamping ring, spacer, and holding ring.
10. Head recovery section.

Maintenance is nil

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Take the moving parts out of a rate-of-flow controller and you've taken away practically all your maintenance—and that's just what you can do with this new Simplex Modulair Flow Controller.

The only moving part inside your pipeline is a non-corroding rubber throttle.

There are no line valves, no pilot valves, no pistons or valve shafts. Not even a stuffing box to pack.

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New bulletin. Bulletin 951 explains the Modulair design in greater detail and shows pictures of installations where Modulair has been in actual filter plant operation for over seven years.

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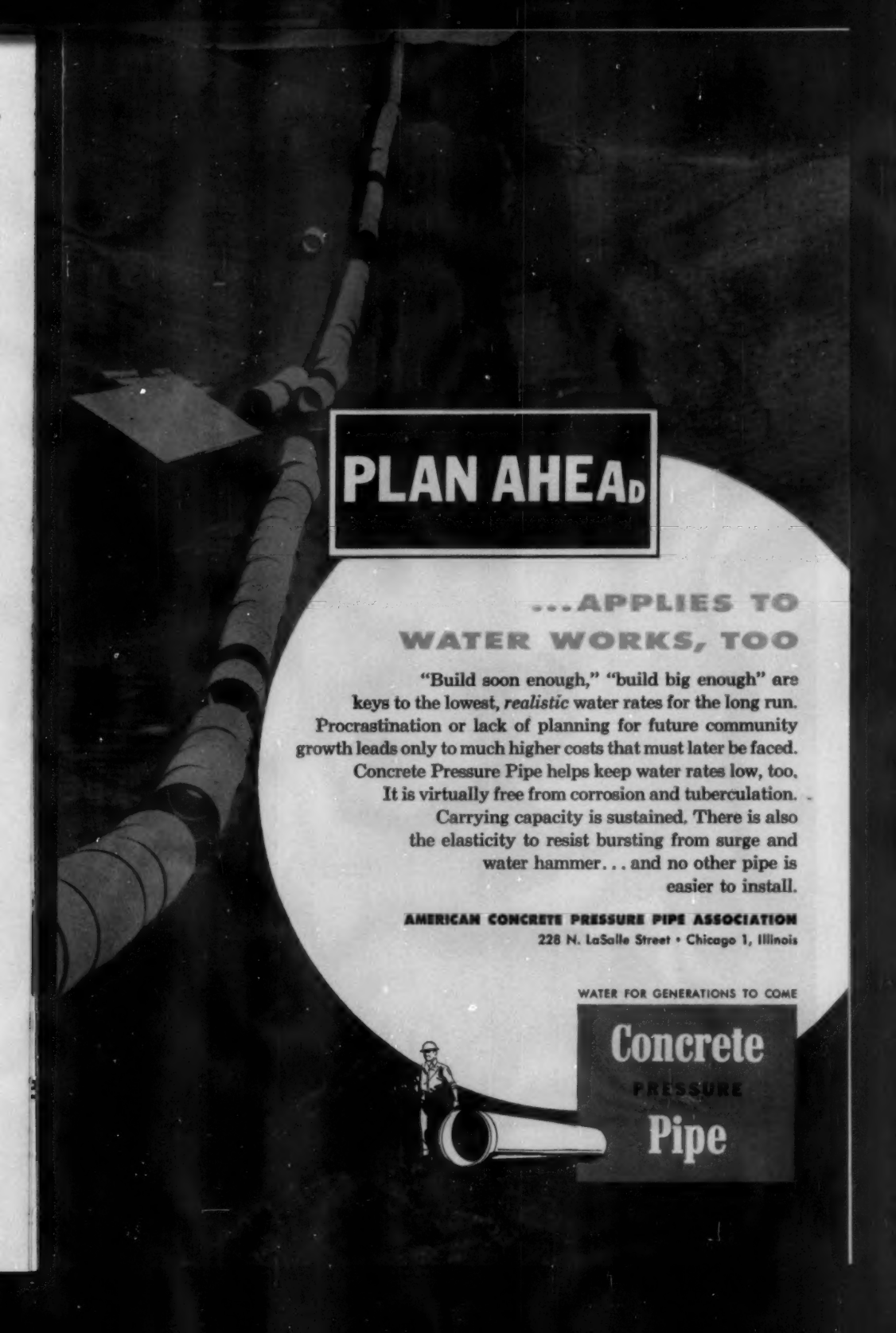
Write to our nearest office for an estimate or information.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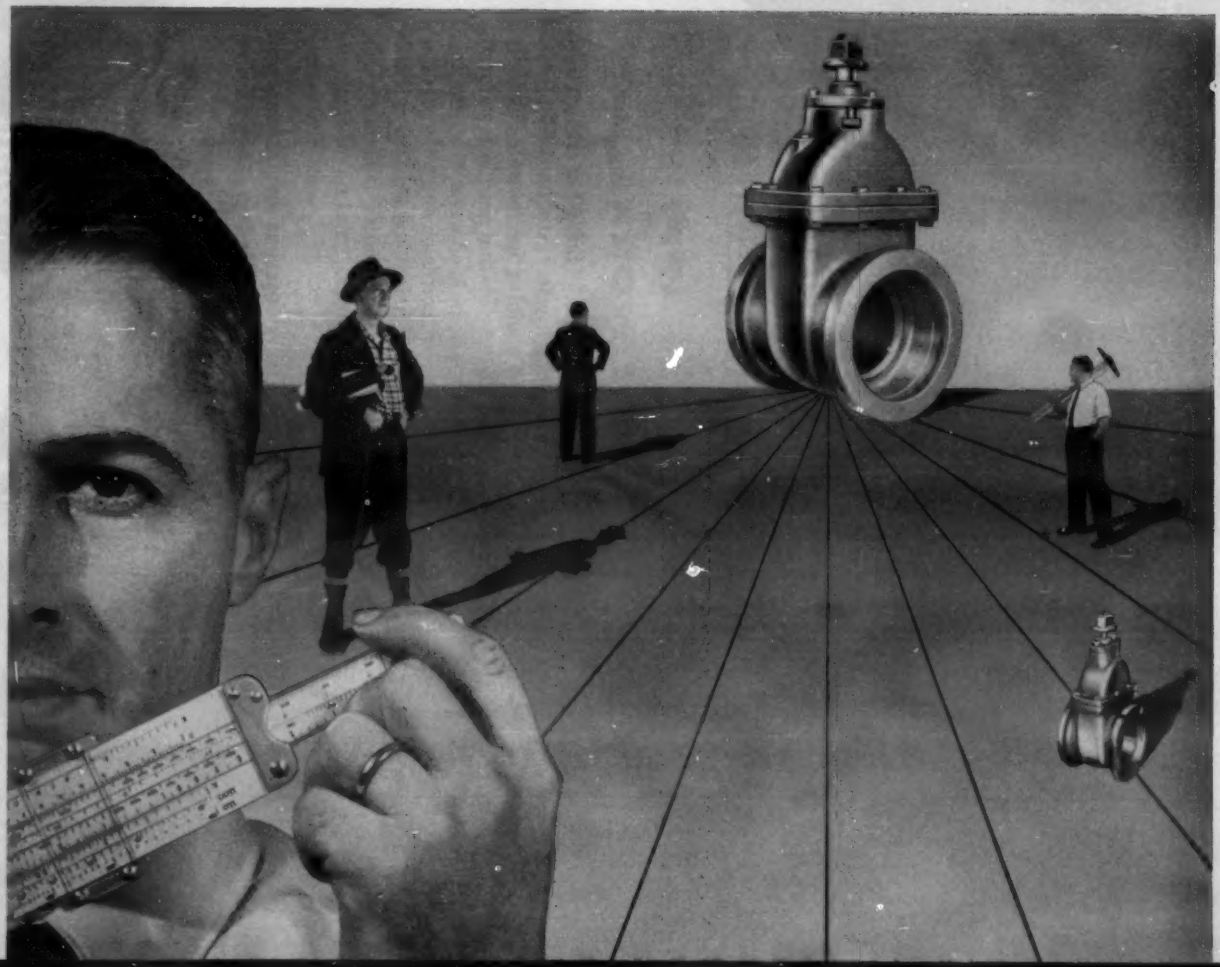

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Sound design and quality workmanship to guarantee ease of operation, watertight closure, years of trouble-free performance

The perfect gate valve, according to engineers and water superintendents, must combine simplicity and soundness of design, tightness of closure, ease of operation and quality of workmanship.

All Ludlow gate valves and all Rensselaer gate valves are designed to meet these requirements, as well as A.W.W.A. specifications.

Among the Ludlow and Rensselaer double disc gate valves you'll find the most complete selection of outstanding design features available today. Sizes range from 2" to 72", plus custom design engineering for special applications.

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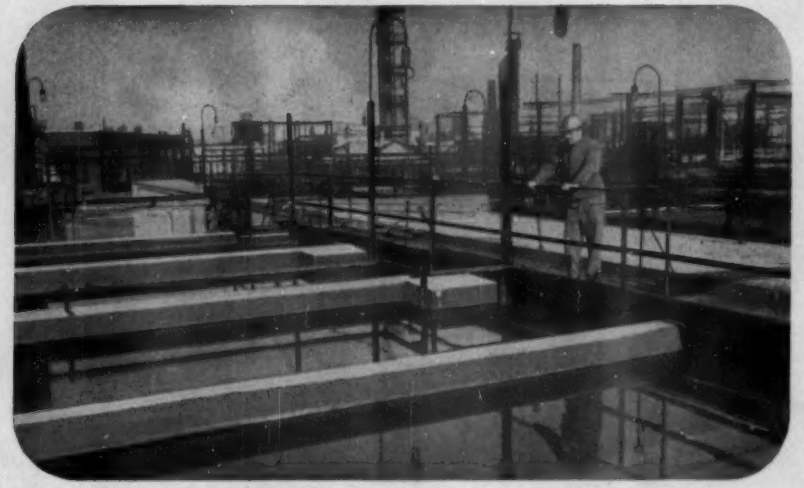
LUDLOW & RENSSELAER

VALVES AND HYDRANTS

THE LUDLOW VALVE MANUFACTURING CO., INC., TROY, N. Y.—SINCE 1861



This open-tank softener has been in continuous service since 1950 using its original AMBERLITE IR-120 resin.

AMBERLITE IR-120 in use over 7 years at oil refinery has treated 3,000,000 gallons of water per cubic foot of resin . . . shows no significant change in softening capacity.

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While there are many installations which have given such prolonged service, the durability of ion exchange resins is dependent upon the nature of the influent water supply and operating conditions. Engineering companies specializing in water treatment are qualified by experience to give you recommendations on how AMBERLITE ion exchange resins can best serve your specific needs.

If you need softened, deionized, dealkalized or deacidified water, you'll find the answer to your water conditioning problems in our booklet "If You Use Water".

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Municipal water needs vary and that's why Layne produces pumps in a variety of sizes and capacities, each designed and engineered to deliver the required GPM economically and unfailingly.

Layne pumps are backed by over 75 years of experience gained around the world.

* *Gallons per minute per Layne Pump*

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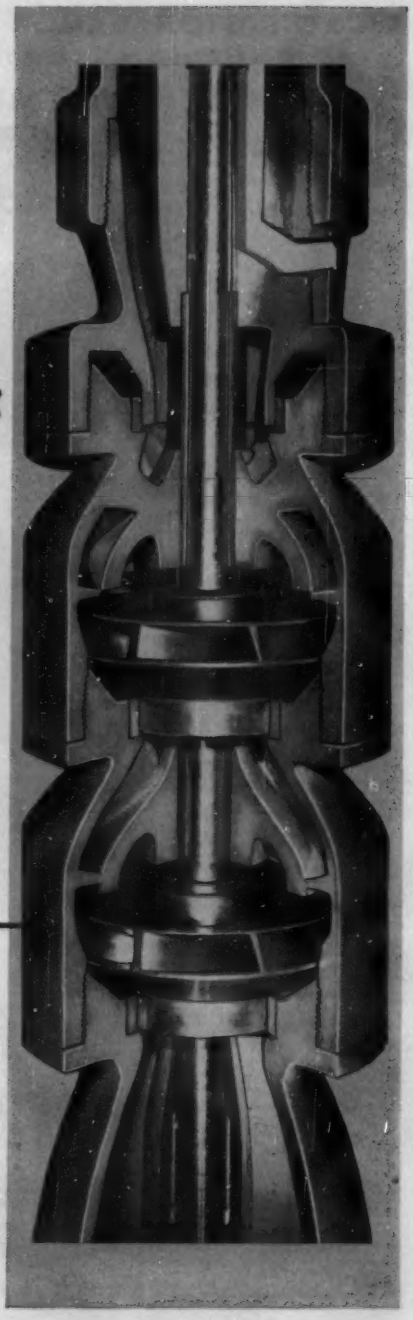

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The meter used by thousands of municipalities in the U. S.

"Watch Dog" models . . . made in standard capacities from 20 g.p.m. up: frost-proof and split case in household sizes. Disc, turbine, or compound type.

SURE TO MEET YOUR SPECIFICATIONS FOR ACCURACY, LOW MAINTENANCE, LONG LIFE.

Before you invest in water meters, get acquainted with the design and performance advantages which make Worthington-Gamon Watch Dog Water Meters first choice of so many municipalities and private water companies in the United States.

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KENNEDY VALVE has a complete line of A.W.W.A. Standard Gate Valves . . .

. . . that conform to A.W.W.A. specifications in all respects

FIG. 56
- Inside Screw
- Non-Rising Stem
- Parallel Seats
- Bell Ends

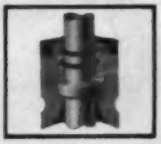
FIG. 571X
- Inside Screw
- Non-Rising Stem
- Parallel Seats
- Mechanical Joint Ends

FIG. 561
- Inside Screw
- Non-Rising Stem
- Parallel Seats
- Flanged Ends

FIG. 560
- Outside-Screw-and-Yoke
- Rising Stem
- Parallel Seats
- Flanged Ends

Construction features . . .

Conventional stuffing box
with adjustable gland has ample space for packing that conforms to Federal specification HH-P-106c. The bottom face of the stuffing box flange is faced smooth to form bearing surface for stem thrust collar.



O-Ring seals
once installed no adjustment of any kind is required. The top O-Ring is the dirt seal and the bottom O-Ring is the pressure seal.

Operating nut
is Higher Strength Cast Iron. The base flange, with arrow indicating direction to open, is shaped to permit access from ground surface to adjust gland nuts with an extension socket wrench.

KENNEDY A.W.W.A. Standard gate valves are designed specifically for use in water works systems. Conforming to A.W.W.A. Specifications, in several particulars these valves exceed these standards of strength and refinements of design.

While A.W.W.A. Specifications cover only bell end and flanged end non-rising stem valves, the KENNEDY line also includes outside-screw-and-yoke valves and a wide variety of pipe connections including: Bell Ends, Flanged Ends, Mechanical Joint Ends, Universal Pipe Ends, Asbestos Cement Pipe Ends, Screwed Ends, Ring-Tite Pipe Ends and Spigot Ends.

In addition to standard features, KENNEDY A.W.W.A. Valves have reduction gearing, gear cases, by-passes; indicators and rollers, tracks and scrapers available on 16" and larger sizes. Gearing is always furnished on 30" and larger valves.

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Steady, dependable water service—that's a major reason for the trend to "K&M" Asbestos-Cement Pressure Pipe. Once it's installed, you can forget about it. Year after year, the water keeps flowing through . . . clear and unimpeded by tuberculation, corrosion, or electrolysis. The combination of asbestos fibers and portland cement provides a rock-like durability.

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See the new "K&M" film, "Lifelines of Your Community." It's the exciting, dramatic story of "K&M" Asbestos-Cement Pressure Pipe from manufacturing to installation. Learn how your community can enjoy the finest water service . . . uninterrupted . . . at lowest cost. How you can rid yourself of costly, time-consuming repairs and replacement.

"Lifelines of Your Community" is now available for council meetings, engineer or waterworks association meetings, or to other interested groups. Write to us. We'll make arrangements for showing the film . . . and give you complete information on "K&M" Asbestos-Cement Pressure Pipe.

THE WATER SUPERINTENDENT

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He says, "Accurate American Meters discourage waste and thereby help us meet the peak seasonal demands on the water system!"

Most water waste is not willful—just forgetful—forgetting the hose is running, forgetting to shut a faucet tightly, forgetting to get a leaking faucet or toilet valve repaired. When American Meters are on the job, accurately registering such waste, forgetfulness disappears. Plumbing leaks are quickly repaired. With less waste, equipment is able to meet peak requirements at full pressure.

And superintendents who use American Meters, know that even after 30 or more years of service, they will still be silently, accurately, dependably earning water revenue in full. That's why they continue to buy AMERICAN.

The Meter with the thick disc that compels full accuracy.

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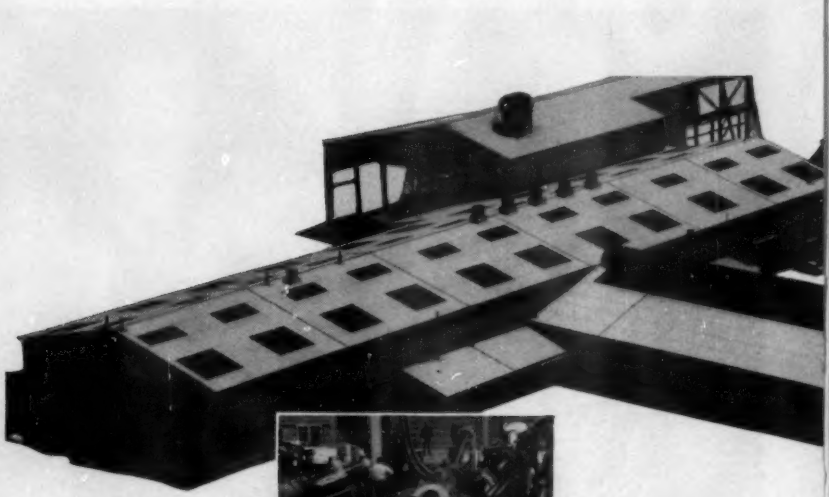

Using the metal mold process, the new casting machines at Bensenville include many patented improvements which are unique with Clow

Testing is a continuous phase of the manufacturing process. All Clow pipe is subjected to a hydrostatic test of 500 lbs. per sq. inch of water pressure—2 to 4 times the normal working pressure.

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The Key to Clow's High Quality

Clow cast iron pipe quality is assured by automatic instrument control during manufacture. In some cases, these control systems were developed exclusively for Clow.

Pipe annealing, a vital step in making Clow cast iron pipe, is carried out in this annealing oven —the most modern of its kind.

New Cast Iron Pipe Plant Begins Production to Meet Growing Midwest Market Demands

On September 22, 1958, the first pipe was poured at the new Bensenville, Illinois, Works of JAMES B. CLOW & SONS, INC., starting production at the most modern cast iron pipe plant in the world. The first plant ever constructed in the central states area for making cast iron pipe, Bensenville is located in suburban Chicago and is ideally situated to meet present and future demands for Clow pipe. By bringing producer and users hundreds of miles closer together, this new manufacturing plant will be able to deliver dependable Clow cast iron pipe *faster* for all construction needs. Bensenville is strategically located for shipment by rail, or by truck over the modern new highway network of the Chicago area. In addition, customers will benefit from new efficiencies of modern mass production in a plant located in an area central to vital raw materials for making cast iron pipe.

The inauguration of pipe production at Bensenville marks another step in Clow's continuing expansion program. Clow now operates pipe plants at Coshocton, Ohio, and Birmingham, Alabama, in addition to Bensenville. Bensenville is another major Clow investment in better products to better serve its customers.

OUR 80TH YEAR • 1878 TO 1958

CLOW CAST IRON PIPE

JAMES B. CLOW & SONS, INC.

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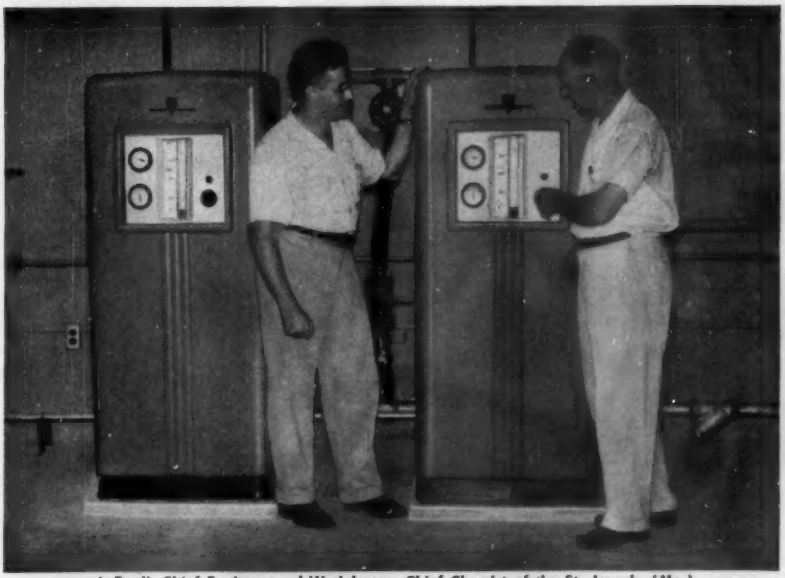

J. Pauli, Chief Engineer and W. Johnson, Chief Chemist of the St. Joseph, (Mo.) Water Company, discuss operation of their W&T V-notch chlorinators. The St. Joseph Water Co. is part of the American Water Works Service Co., Inc. system.

W & T V-notch Chlorinators — doubly accepted

The St. Joseph Water Co. found breakpoint chlorination the best way to treat Missouri River water. But this increased the range of chlorine requirements in the water treatment. W&T V-notch chlorinators were the answer.

W&T V-notch chlorinators have a chlorine feed range of 20 to 1 with an accuracy of 4%. Based on this acceptance at its St. Joseph plant, the American Water Works Service Co., Inc. has purchased V-notch equipment for use in other plants.

V-notch chlorinators are available to feed from 2½ to 8000 pounds of chlorine per 24 hrs. V-notch equipment also provides permanence and attractiveness through modern reinforced plastics. For comprehensive information about W&T V-notch chlorinators, write for Bulletin S-122.05.

WALLACE & TIERNAN INCORPORATED

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Journal
AMERICAN WATER WORKS ASSOCIATION
VOL. 50 • DECEMBER 1958 • NO. 12

Should AWWA Standards Be Enforced?

Louis R. Howson

A revision of a paper presented on Apr. 21, 1958, at the Annual Conference, Dallas, Tex., by Louis R. Howson, Partner, Alvord, Burdick & Howson, Engrs., Chicago, Ill., and Chairman, AWWA Water Works Practice Committee.

THE question of whether AWWA standards should be enforced has been under serious consideration for a long time. To obtain a comprehensive view of the problem, it is necessary to analyze it by asking and answering several other questions, including the following:

1. Why are AWWA standards prepared?
2. What is the extent and present status of AWWA standards?
3. Who uses AWWA standards and how extensively are they used and relied upon?
4. Are AWWA standards serving a real need?
5. Is compliance with AWWA standards essential in the public interest?
6. Whose responsibility should it be to see that materials purchased under AWWA standards are in compliance with them?
7. Should compliance with AWWA standards be voluntary or compulsory?
8. Who, if anyone, should do the policing?

Background

The preparation of AWWA standards has developed progressively over a period of several decades. Initially, standards were prepared for items of water works construction which were universally used, such as cast-iron pipe, valves, and hydrants. Some utilities had been buying pipe that was too thick, others too thin—both being uneconomical. Variations in shell thickness when horizontal molds were used likewise presented a problem, and the industry had had bitter experience with short-lived materials. Difficulties were also caused by nonuniformity in protective-coating constituents, in valve design, in hydrant nozzle diameters, and in valve and hy-

drant threading and direction of turn. Standards were drawn up to deal with these matters.

From this beginning, the study and preparation of standards have continuously advanced. AWWA created a standards committee (now the Water Works Practice Committee) almost 40 years ago. Under its direction approximately 60 standards have been prepared, covering materials, equipment, structures, and procedures used extensively in the operation of water utilities. Although statistics are not available, the author's estimate is that at least $250,000,000 worth of materials are now purchased under AWWA standards each year. Of course, standardization procedure must keep pace with progress in the development and economical utilization of materials. AWWA standards are, therefore, continuously under scrutiny and are revised when necessary.

Certainly, AWWA standards perform a necessary service for both the suppliers and the users of water works materials. In so doing, such standards contribute to the public welfare. The water works industry relies very greatly on them and places orders in the belief that it will receive materials complying with the standards when so specified. Occasionally, an unscrupulous manufacturer furnishes a product that fails to conform, in material or construction, to the AWWA standard specified by the purchaser. Sometimes defective products even carry the initials "AWWA."

Because such abuses are infrequent, it might be argued that their elimination is not worth the effort and cost. If rare abuses are ignored, however, conditions may get worse. Particularly vulnerable are those cities where a general purchasing agent is so unfamiliar with the water works materials and equipment he buys that he cannot judge whether they comply with the AWWA standards he specifies. This situation is not imaginary.

And yet, for AWWA alone to take on the burden of insuring compliance with its standards would involve complications and expenditures that do not appear warranted by conditions at this time. It seems to the author that responsibility for compliance is divided three ways:

1. AWWA must make available to the public the best standards that can be produced. These must be kept up to date. They should specify minimum requirements; point out specific limitations, if any, on general application; and offer an economical solution for both the purchaser's service problem and the manufacturer's production problem.

2. The purchaser should keep himself informed about the materials desired and the AWWA standards that apply in order that he may limit his selection to materials which comply with the standards.

3. The manufacturer should comply with the standard governing the material on which his bid is requested. If the material varies from it in any way, it is his obligation either to refrain from quoting or to submit in writing to the purchaser a description of the manner in which his product deviates from the standard.

AWWA Certification Program

This threefold division of responsibility is reflected in the certification program developed by the AWWA Board of Directors and now being carried into effect. An AWWA mark has been adopted, and manufacturers of products covered by the program may apply for a license to display it

as a warranty to the purchaser of their compliance with the AWWA standard involved. The purchaser is not relieved of his share of responsibility, however, because AWWA is *not* certifying that products bearing the AWWA mark conform to its standards. AWWA is simply providing a means by which manufacturers may certify, voluntarily, that their products meet particular AWWA standards.

At present the only materials for which license applications are being accepted under the program are gate valves in sizes up to and including 12 in., conforming to AWWA C500. Details of the application procedure follow the official AWWA statement of policy beginning on page 1542 of this issue.

Conclusion

The author believes that:

1. AWWA standards are serving a real need in the water industry and are contributing to the public welfare.

2. AWWA standards should be enforced.

3. Enforcement can be very much strengthened by the voluntary procedure adopted by the Board of Directors.

4. Voluntary compliance will probably be sufficient, but if it is not, stronger measures should be studied and adopted.

5. The procedure herein outlined should be viewed as probationary and subject to continuing observation. Its success depends upon full cooperation from all segments of the water works industry.

An industry which is as essential to modern living as the water works industry must have minimum standards for construction and operating materials. AWWA has long been the leader in developing such standards, and their excellence is universally recognized. AWWA should also be instrumental in seeing that its standards, when specified, are complied with.

AWWA Certification Policy

THE Board of Directors of the American Water Works Association, noting the potential value to the public and to the water supply industry, have agreed that a procedure should be developed by which producers of water works construction and operating equipment and supplies may guarantee to purchasers that their products conform to relevant AWWA standards.

It is the intent of the Board of Directors that the Association shall establish a certification procedure whereby a manufacturer, upon warranting to AWWA that his product conforms to the applicable standard, may, pursuant to revocable license, place upon his product an AWWA certification mark. This mark will serve as a guarantee by such manufacturer to the purchaser that the product so conforms.

It is proper that the Board should prescribe a method by which producers of water works material may guarantee their equipment and material. Therefore, the Board plans the following steps:

1. To adopt a certification mark
2. To license one or more manufacturers to use the mark
3. Upon use of the mark by a licensee in interstate or foreign commerce, to apply for registration of the mark in the US Patent Office.

Accordingly, the Executive Committee of the Board, on Sep. 8, 1958, authorized the issuance of a statement of certification policy; accepted the recommendations of the Committee on Certification regarding the license application form; limited the initiation of the program to gate valves in sizes up to 12 in., conforming to AWWA C500; and instructed the AWWA Secretary to communicate the details of the certification procedure to Associate Members of AWWA listed as manufacturers of gate valves.

Statement of Policy

1. A certification mark in the form set forth here:

is adopted as the certification mark of the American Water Works Association, to be placed by licensees on their products as a warranty by each licensee that the product upon which the mark has been placed conforms to the applicable AWWA standard.

2. There is created a Committee on Certification, the members of which shall be appointed by the President, on the recommendation of the Chairman of the Water Works Practice Committee, from among the members of that committee. The duties of the Committee on Certification shall be as hereinafter set forth. The committee shall have power to perform such duties.

3. All correspondence concerning applications for license to use the mark, as well as the certification program in general, shall be conducted by the AWWA Secretary and his staff.

4. The certification program shall be administered by the Secretary, subject to the orders of the Board of Directors. The Board of Directors shall determine the standards which shall from time to time be included in the certification program and shall fix the rates of application fees and license fees. At each stated meeting, the Secretary shall report to the Board regarding the certification program. The Board may, but need not, review any action regarding certification taken by the Secretary and modify such action to the extent, if any, deemed desirable by the Board.

5. The Certification Committee shall advise the Secretary regarding the form of application for license from time to time to be used, and regarding each application for license. Such advice as to an application may be a recommendation to the effect that a license should be granted or be denied; or that further information should be required from the applicant; or that random samples of the applicant's product should be procured through trade channels and tested to determine the conformity of such samples to the standard; or to such other effect as the committee shall determine. On its own motion the committee may, and on request of the Secretary the committee shall, recommend to the Secretary whether a license should be continued or revoked; and such advice may take any of the forms above referred to with respect to an original application. On its own motion the Committee may, and on request by the President or Secretary the committee shall, from time to time, advise the Board or the Secretary regarding other questions pertaining to the certification program.

6. No license shall be granted unless and until the applicant shall have furnished to the Secretary a warranty that the product conforms to the applicable AWWA standard. In addition to the warranty furnished by the applicant, the Secretary may require such other information as he deems necessary as a condition for further consideration of the application. Such additional information may include the testing of random samples of the product procured through trade channels or otherwise, all at the expense of the applicant. Information so obtained shall be held confidential. Each application shall contain, among other provisions, agreement by the applicant that:

a. All examples of the product offered for sale or lease will conform to the standard

b. The standard may be amended or withdrawn, whereupon the license shall be deemed revoked on the effective date of the amendment or withdrawal

c. The applicant will notify AWWA of any change in the product or in the applicant's manufacturing and testing procedures pertaining to the product

d. On request, the applicant will file an application for continuance of the license

e. The applicant will hold AWWA, its officers, directors, and committee members harmless from loss or damage due to granting or denial of the application or revocation of the license

f. The applicant will be bound by denial of the application or revocation of the license.

7. AWWA shall hold harmless its officers, directors, and committee members in respect of their lawful acts pursuant to this directive. No AWWA Member or Associate Member shall, on pain of censure or expulsion, assert any claim or maintain any action, suit, or proceeding against AWWA, its officers, directors, or committee members by reason of the granting, continuance in effect, denial, or revocation of any license to use the AWWA certification mark.

8. The Secretary shall consider any information that he may receive concerning the conformity of a licensed item to the applicable AWWA standard and may, at any time following receipt of such information or other pertinent data, after a formal hearing, determine that a licensed item does not comply with the applicable AWWA standard and terminate the license in respect of such item.

Limitation of Program

Until the further order of the Board of Directors, the mark will be applicable solely to gate valves (only in sizes up to and including 12 in.) conforming to AWWA C500–52T—Tentative AWWA Standard for Gate Valves for Ordinary Water Works Service, amended as follows:

Section 24—Markings

Sec. 24.1—General

Markings shall be cast on the bonnet or body of each valve showing the manufacturer's name or mark, the year the valve casting was made, the size of the valve, and the designation of working water pressure (150 W or 175 W). Special markings in addition to these can be supplied, when specified by supplementary requirements, upon agreement between purchaser and manufacturer.

Sec. 24.2—Optional Use of AWWA Certification Mark

A manufacturer licensed to do so may, subject to the provisions of the license, place on each valve made by him the registered certification mark of AWWA.

Sec. 24.3—Unauthorized Reference to AWWA

Except as provided in Sec. 24.2, no valve shall bear any mark in any way referring to this standard or to AWWA.

Application Form

A form for application for a revocable license to use the AWWA certification mark on gate valves up to 12 in. has been prepared. The application (reproduced below) consists of a warranty and agreement to which the applicant must subscribe, together with a detailed statement, in tabular form, of conformity to AWWA C500, item by item, paragraph by paragraph.

Copies of the application form, as well as other information regarding the certification program, may be obtained from the Secretary, American Water Works Assn., 2 Park Ave., New York 16, N.Y.

Application for Revocable License to Use AWWA Certification Mark

(For Gate Valves up to and Including 12 in., Conforming to AWWA C500)

American Water Works Association
Attention: Secretary
2 Park Avenue
New York 16, N.Y.

Dear Sir:

1. The undersigned, an officer of ....., hereby warrants that gate valves for water mains described in our published catalog and/or engineering data sheets, under the class description as ....., in size(s) ....., regularly manufactured by us since on or about ....., at our own plant located at ....., conform to AWWA Standard C500. Our published catalog or engineering data sheets, as well as certified engineering drawing(s), is (are) attached to this application as Exhibit 1.

2. We hereby apply for license to display the certification mark on each example of the licensed item(s) sold or leased by us, such use of the mark by us to be a warranty by us to the purchaser that each example conforms to the applicable standard. We understand that use of the certification mark on our product pursuant to such license, if granted, will be a representation and warranty by us that the product conforms to the applicable standard, and that AWWA does not represent or warrant that the product bearing the certification mark conforms to the standard.

3. While the license shall be in effect, we warrant that each example of the certified item(s) offered for sale or lease by us will have been subjected to the tests set forth in the applicable AWWA standard and will conform in all respects to the standard.

4. To induce you to accept our warranty, we submit herewith as Exhibit 2 an itemized statement covering the characteristics of the product(s) manufactured by us.

5. We agree to submit to you such additional pertinent information as you may request at any time while this application is under consideration or a license to us to use the certification mark is in effect. Should a hearing be necessary during the time that the application is under consideration, we agree to attend such hearing called by you, at a time and place to be set by you, on reasonable written notice to us.

6. In passing on this application and in considering from time to time whether the license shall remain in force, we understand that you may take into account any additional information which you deem pertinent, including, but not limited to, tests of an example of the licensed item(s) manufactured by us. If this application is denied we agree to be bound by that action.

7. We understand that the license may be revoked by you at any time upon determination by you that the licensed item(s) no longer conform(s) to the standard; and, provided that a hearing is held upon the proposed revocation, on reasonable notice to us, we agree to be bound by such revocation.

8. While the license shall be in effect, we may place the mark on all examples of the licensed item(s) manufactured by us which conform(s) to the standard. Upon

receipt of written notice of revocation of the license, we will forthwith cease to place the mark on any goods. For 6 months after receipt of such notice, we understand that we may sell and/or lease examples of the licensed item(s) on which, prior to receipt of such notice, the mark was cast, stamped, or otherwise imprinted on metal other than a label. Except pursuant to the provisions of the license, including the provisions of this application, we will not use the mark and we will not place any other mark or brand on any goods referring in any way to AWWA.

9. AWWA may, but need not, from time to time publish in its JOURNAL, and in its other publications, notice of the granting, continuance, or termination of the license, either by including our name in, or eliminating our name from, any list, or by any other method.

10. We understand that AWWA remains free to revise or withdraw Standard C500 at any time, provided that its routine procedures relating to standardization have been followed. In case of withdrawal of the standard, any license granted under the terms of the standard shall be deemed revoked as of the published effective date of such withdrawal. We also understand that if the standard is revised by AWWA under its routine procedure, all licenses granted under that standard shall expire as of the published effective date of the revision; and a renewal application to use the mark on item(s) represented to conform to the revised standard will be filed by us in conformity with the terms of the AWWA certification procedure.

11. We understand that if we change the engineering details of any licensed item so that the end product does not conform to the current standard, the Secretary will be fully advised, and the license may be reviewed and/or revoked.

12. Neither this application nor any license issued pursuant thereto shall take effect except pursuant to the laws of the State of New York, and may not be changed, modified, or discharged except by a written agreement signed by you and by us.

13. Any notice shall be validly sent to us and shall be deemed to have been received by us in the regular course of the mails if deposited in the mails enclosed in a sealed, postpaid wrapper, addressed to us at our address hereinabove set forth, or at such other address as we shall have placed on file with you in writing.

14. In filing this application for license, we certify that we have read the statement of AWWA certification policy adopted by the Executive Committee of the Board on Sep. 8, 1958, and, so long as the license herein applied for is in effect, we agree to abide by the terms of that policy.

15. We herewith enclose our check in the sum of $50 to cover the application fee ($25) and the annual license fee ($25) for the first year.

.....	.....
Name of Company	*Officer*
.....	.....
Address	*Title*
.....	
	.....
	Date

EXHIBIT 2 *

Detailed Statement of Conformity to AWWA Standard C500-52T

Section or Paragraph Number	Subject	Conform	Deviate
1.2	Valve pressure ratings		
2.3.1	Cast iron		
2.4.1	Bronze—Grade I		
2.4.2	Bronze—Grade II		
2.4.3	Bronze—Grade III		
2.4.4	Bronze—Grade IV		
2.4.5	Bronze—Grade V		
2.5.1	Steel		
2.5.2	Carbon steel		
2.6.1	Babbitt		
3.1	Resistance to stress		
3.2	Basis of structural design		
3.3	Size of waterway		
4.1.2	Design		
4.1.3	Design		
4.1.4	Design		
4.1.5	Design		
4.2	Material		
5	Bonnet bolting: Cadmium plated, or Zinc coated, or Otherwise rustproofed (how?)		
6.1	Ends for bell-and-spigot pipe		
6.2	Ends for flanged pipe		
6.3	Ends for mechanical-joint pipe		
7.1.1	Gate rings tight		
7.1.2	Gate rings: Rolled, or Peened, or Pressed		
7.1.3	Finish cuts		
7.1.4	Gate ring faces		
7.2.1	Gates: Cast iron or Bronze Wedges: Cast iron or Bronze		
7.2.2	Gate rings—bronze		
8.1.1	Body seat rings—how inserted		
8.1.2	Body seat rings—sufficient width		
8.2	Body seat rings—material		
9.1	Wedge design		
9.2.1	Bronze for wedges: Grade I, or Grade II, or Grade III		
9.2.2	Pins and bolts (wedging mechanism)—Grade IV bronze		
9.2.3	Wedging surfaces (valves 3–12 in.): Bronze to bronze, or Bronze to iron, or Monel		
10	Guides—solid-wedge valves		
11.1.2	Discs serve as rollers		
11.1.3	Bronze rollers attached		
11.3	Scrapers		
12.1.1	Stem collars made integral		
12.1.2	Threads: Square, or Acme, or Modified Acme, or Half V		
12.1.3	Threaded straight and true		
12.1.4	Minimum diameter		
12.1.5	Lead not more than $\frac{1}{4}$ in.		
12.2.1	Stems: Cast bronze, or Forged bronze, or Rolled bronze		
12.2.2	Bronze for cast stems: Grade II or Grade III Bronze for forged and rolled stems—melt requirements of Table 3		
12.2.3	Stem nuts—bronze: Grade I, or Grade II, or Grade III		
13.1.1	Stuffing box: Can be packed under pressure O-ring stuffing box		
13.1.2	Stuffing box—machining		
13.1.3	State ratio of stuffing box diameter to stem diameter		

* For Exhibit 1, see Paragraph 1 of application form.

EXHIBIT 2 (*contd.*)—*Detailed Statement of Conformity*

Section or Paragraph Number	Subject	Conform	Deviate
13.2.1	Stuffing box material—cast iron		
13.2.2	Stem collar thrust bushing—Grade I bronze		
13.2.3	Stuffing box bolts and nuts—steel		
	Rustproofing:		
	Cadmium plated, or		
	Zinc coated, or		
	Otherwise rustproofed (how?)		
14.1	Packing:		
	Asbestos or		
	Flax		
15.1.1	Gland assembly:		
	Solid, or		
	Solid bushed, or		
	Two piece		
15.1.2	Gland flanges:		
	Flanged end on gland or		
	Separate part		
15.2.1	Gland material—bronze		
15.2.2	Gland flange—state what material		
15.2.3	Gland bolts:		
	Grade II bronze, or		
	Grade IV bronze, or		
	Rustproofed steel (Sec. 5)		
	Gland bolt nuts—bronze:		
	Grade II, or		
	Grade III, or		
	Grade IV		
16.1.1	Wrench nuts—secured by:		
	Nut, or		
	Pin, or		
	Key		
16.1.2	Wrench nut:		
	Size		
	Direction arrow		
16.1.3	Wrench nut base cut away		
16.2	Wrench nut material—cast iron		
17.1.1	Gear bearings:		
	Bronze lined or		
	Babbitt lined		
17.2.1	Cut-tooth gears—steel		
17.2.2	Babbitt lining for bearings		
18	Gear cases:		
	Extended type or		
	Totally enclosed type		
19	Indicator (when required)		
21.1	Gasket design:		
	Full cut or		
	Inside bolt circle		
21.2	Gasket material:		
	Sheet asbestos, or		
	Rubber composition, or		
	Paper		
22.1	General workmanship		
22.2.1	Spot facing (when required)		
22.2.2	Castings without defects		
23	Painting:		
	State material used		
	State how applied		
24	Marking		
25.1	State whether these tests are made with satisfactory result before valve is shipped		
25.2.1	State whether these tests are made with satisfactory result before valve is shipped		
25.2.2	State whether these tests are made with satisfactory result before valve is shipped		
25.2.3	State whether these tests are made with satisfactory result before valve is shipped		
25.2.4	State whether these tests are made with satisfactory result before valve is shipped		
26.1	State what happens to rejected parts		
26.2	State whether prepared to certify conformance of test results to this standard if customer so requests when order is placed		
27.1	Shipping requirements		

Efficient Design and Operation of Chemical Distribution Systems

Virgil W. Langworthy

A paper presented on Sep. 23, 1958, at the Kentucky-Tennessee Section Meeting, Memphis, Tenn., by Virgil W. Langworthy, Chief Project Engr., Utilities Sales Div., B-I-F Industries, Inc., Providence, R.I.

THE design of machines to feed into water the chemicals required for proper treatment has been improved through the years by the application of sound engineering principles. Design has improved to a point where the selection of these machines, even for difficult or unusual functions, is routine.

There is, however, another important phase of the chemical-feeding operation which has not had the benefit of the same engineering approach: design and operation of the system which transports the dissolved chemical to the point of application. An advanced feeder installation can measure accurately and dissolve completely the required chemicals but this is useless if the solution cannot be transported to the point of application. It is the purpose of this article to review some common practices in the area of design and operation of chemical distribution systems and to suggest improvements.

Design

Lines which carry chemical solutions can fail in two ways: they can corrode and leak or they can scale and plug. These failures may be caused by either improper operation of the feeder or by inadequate design. Whatever the cause, replacement or repair will be required. Many present design practices, however, prevent this from being easily accomplished.

The most consistent oversight in connection with maintenance and replacement is the practice of burying chemical feeder lines instead of leaving them accessible. It may make a slight improvement in the appearance of the installation to have the lines hidden, but it makes them very difficult to repair.

If the feeder lines are accessible they should be flexible instead of rigid. Replacing flexible pipe is a much easier task because a rigid pipe is much harder to place in position. Also, if scaling occurs in a flexible pipe it may often be cracked off the inside of the pipe by bending and flexing.

The plugging of chemical feeder lines by scale is an important problem because a scaled line offers resistance to solution flow. Scaling can be postponed by the use of larger-diameter solution lines but if the conditions which cause scaling are present even the largest line will eventually become plugged. The use of troughs instead of closed conduits is an alternative design to avoid plugging. Scaling will occur in a trough if the conditions are right but troughs are easily cleaned;

therefore, their capacity need never be materially reduced.

Another common solution-line problem is caused by too long a line to the point of application. If a line is too long it often requires too much work to maintain the proper flow. This may be avoided by moving the chemical feeder closer to the point of application.

Solution lines are often installed in such a way that siphon conditions are created. This is not good practice but if it cannot be avoided provision must be made at high points in the system for venting trapped air.

Acid solutions may cause corrosion in feeder lines. A line through which acids are to be fed should be made of a suitable corrosion-resistant material. Enough types of pipe lining, alloy, and synthetic (plastic) material are available to eliminate the corrosion problem. The degree of corrosion caused by certain solution strengths must, of course, be investigated. The preferred material, and possibly an alternate, meeting the requirements should then be specified.

Operation

Trouble can develop in properly designed and installed chemical feeders if they are not operated properly. When alkaline materials, such as lime or soda ash, are being fed improper operation can cause scaling of the solution lines. Alkaline scale in solution lines can occur in two ways: deposition of the material being fed or deposition of calcium carbonate. The lime or soda ash itself can also scale out because of supersaturation. This can usually be remedied by the use of more makeup water if adequate dissolving capacity has been provided.

If alkaline scale is caused by the precipitation of calcium carbonate there are alternative methods of operation which will help to prevent trouble. The reaction of the soda ash with the calcium in the makeup water may be one cause of this type of scale. The use of as little makeup water as possible—short of supersaturation—will help to solve this problem.

If the use of makeup water is reduced to a minimum and scaling still occurs three methods of treatment of the water are available:

1. Calcium carbonate sludge from a softening process may be mixed with the feed solution where it will accelerate the precipitation of the calcium carbonate. This will result in the formation of more sludge but it will minimize the scale forming on the walls of the solution line. The sludge in the line may be kept in suspension by increased turbulence and by maintaining a flow velocity of between 4 and 6 fps.

2. Ion-exchange softened water may be used as makeup water. This will prevent the formation of calcium carbonate by eliminating the calcium ion.

3. Polyphosphate complexing agents may be used to complex the calcium ion, thereby minimizing calcium carbonate precipitation and avoiding scale attachment to the wall of the solution line.

If these treatment methods cannot be utilized scale build-up can be controlled by using a "go-devil" cleaning device in the solution line. A go-devil is essentially an inflated ball provided with link-chain wrapping. The ball is forced through the line hydraulically. One plant uses such a device at least once every 8 hr to prevent plugging in lime-slurry piping.

Study of Synthetic Detergents in Ground Water

John M. Flynn, Aldo Andreoli, and August A. Guerrera

A contribution to the Journal by John M. Flynn, Assoc. Public Health Engr., Aldo Andreoli, Public Health Engr., and August A. Guerrera, San. Chemist, all of the Suffolk County Dept. of Health, Riverhead, N.Y.

THIS study was undertaken in order to determine the extent to which the ground waters of Suffolk County, N.Y., have been contaminated by synthetic detergents, commonly known as syndets. An effort has been made to investigate and determine what relationship may exist between the presence of syndets and depth of wells, distances and directions of wells from cesspools, population densities, age of homes, and other factors.

The study has been primarily confined to a residential area in Copiague in the town of Babylon, N.Y. The chief interest at the outset was in the appearance of syndets in well-water systems supplying individual homes. In the course of the investigation the appearance of syndets in public water supplies was also touched upon. The survey also revealed contamination of wells by industrial wastes in the area studied. Information on syndets in private wells has also been obtained in other areas of Suffolk County but is limited only to the determination of the presence of syndets.

Area of Study

The area of the study (Fig. 1) is approximately 72 sq acres, average plot size is 60 by 100 ft, and the plot density is 5–6 homes per square acre. The area contains 297 homes and vacant plots exist for approximately 30 additional homes.

The homes vary from 700 to 1,000 sq ft in area and are chiefly 1½-story wooden frame dwellings. The houses range from 3 months to 26 years in age with an average age of 7 years. The majority of the houses were constructed during the postwar building boom commencing in 1946. The land was previously subdivided on old filed maps and, therefore, did not come under Suffolk County Department of Health subdivision regulations. A portion of the houses, however, were financed by the Federal Housing Administration or the Veterans Administration and their water supply and sewage disposal facilities were inspected on an individual basis by the Suffolk health department. It is assumed that all these homes were inspected by the Babylon Building Department.

Data relative to the geological nature of the area were obtained from the State Water Power and Control Commission. The logs of seven wells in the general area and their location

are shown by Table 1 and Fig. 1. The logs indicate the strata encountered to be typical for the Glacial strata in this area. With the exception of overlying topsoils and loams, the strata to the depths given (maximum 78 ft) consist of typical Long Island sands and gravel.

Ground water depths in this area vary from 7.5 to 12.0 ft below grade. Information from the USGS indicates the ground water flow to be southerly at a rate of approximately 1–3 ft per day.

The topography of the area is relatively flat, sloping gently to the south.

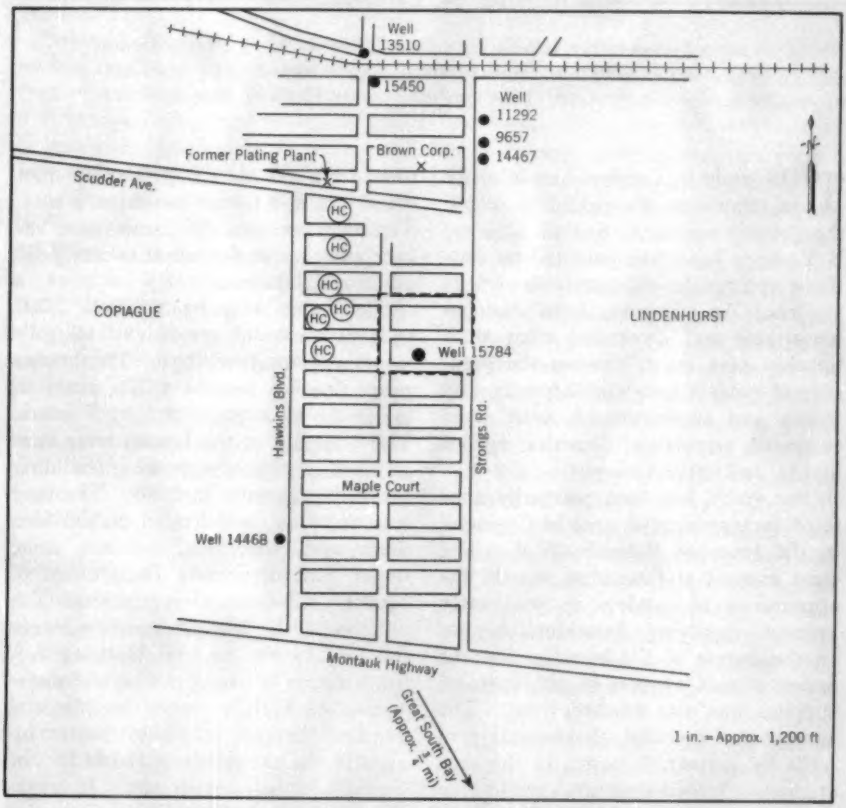

Fig. 1. Area of Study

The study was made in Copiague in the town of Babylon, Long Island, N.Y. The study area is bounded on the north by Scudder Ave., on the south by Maple Court, on the east by Strongs Rd., and on the west by Hawkins Blvd. "HC" indicates the location of the wells contaminated by hexavalent chromium described in the section "Area of Study." The numbered wells are the wells whose logs are given in Table 1. The dotted line indicates the area of the survey described in the section "Study Procedure."

Attention was first directed to the area of study in March 1955 when complaints were received relative to a yellow color in the water from a residential well. Sampling and subsequent investigation showed the cause to be hexavalent chromium from plating wastes discharged into the ground by a plating plant (Fig. 1) north of the contaminated well. The contaminated well was 400 ft south of the point of waste discharge. The plating plant, which had been operating for 2½ years, closed down, and the discharge of waste was thus eliminated. The chromium-contaminated ground water, however, has continued as a ribbon-like slug in a southerly direction and is now 1,200 ft south of the discharge point and has contaminated six wells in its southward path. The position of these wells is indicated by the initials "HC" in Fig. 1.

TABLE 1

Log of Wells in Area of Study

Well No.	Depth to Water *ft*	Soil Layers	
		Depth *ft*	Description
9657	7½	7½–53¼	Sand and gravel
11292	8 1/12	8–53¼	Coarse sand and gravel
14467	7½	7–71	Coarse sand and gravel
		71–72¼	Sand, grits, and bits of clam shells
14468	9	5–63 3/12	Coarse sand and gravel
15784	10	0–2	Topsoil
		2–5	Dark brown sand, grits, and gravel
		5–10	Light brown sand, grits, and gravel
		10–30	Clear, light brown sand, and grits
		30–45	Light brown sand, coarse clam grits, and gravel
15450	6	5–22	Sand and gravel
		22–47	Heavy sand and gravel
13510	7½	0–4	Topsoil
		4–42	Sand and gravel
		42–78	Sand and grit

The investigation into the remainder of the wells serving homes in the area was prompted by general complaints relative to taste, odor, and frothing of water from the wells. The history

relative to frothing led to analysis for syndets.

Syndets

All syndets depend upon some surface-acting agent (surfactant) or wetting agent which does not precipitate with water hardness. In 1948 syndets represented only about 16 per cent of the total annual soap and detergent sales. By 1957 they represented more than two-thirds of total sales.

The composition of syndets is quite variable from product to product. The amount of surfactant used as active agent ranges from 20 to 40 per cent, but an enlightened guess would put it at an average of about 25 per cent. In addition to the active agent, syndets contain 30–50 per cent of a molecularly dehydrated phosphate, mainly a sodium tripolyphosphate. They contain a maximum of 10 per cent sodium silicate, which controls the corrosion of

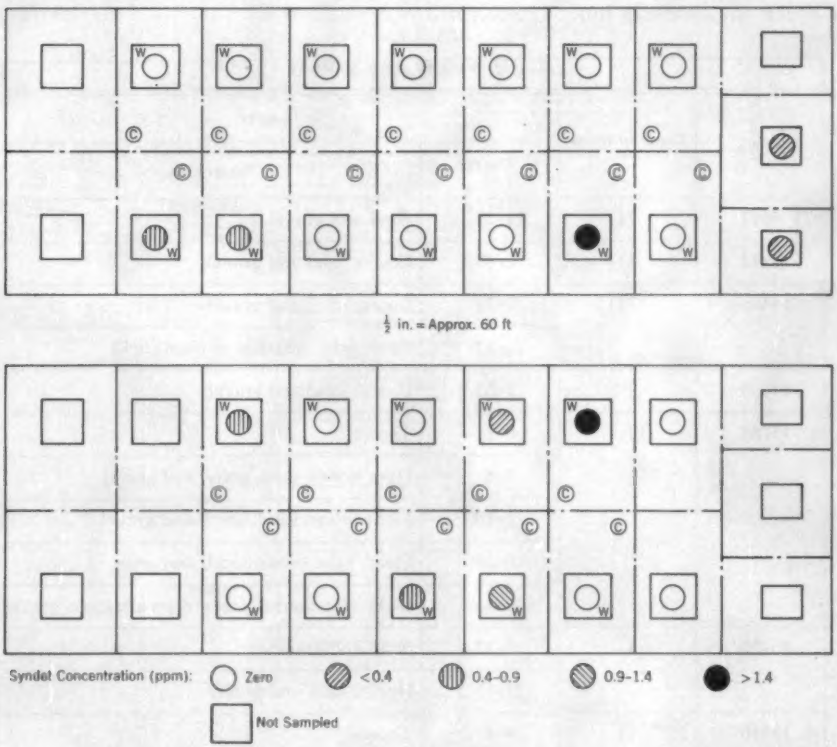

Fig. 2. Survey of Wells and Cesspools in the Study Area

A survey was made of the wells and cesspools in part of the study area. "W" represents the location of the wells of the different houses and "C" the cesspools. The part of the study area covered by this survey is shown in Fig. 1.

metals, particularly aluminum. Syndets also contain a small percentage of condensed amines as foam stabilizers, since most consumers expect some suds, a minor fraction of optical bleach, and a fraction of 1 per cent of carboxymethylcellulose to prevent redeposition of soil on fabrics. Of the surfactants, the petroleum-derived anionics used in syndets now constitute about 75 per cent of the total used, with nonionics next, and cationics only a small percentage of the total, due to their effect on the protein of the skin. Most of the anionics are cyclic; dodecylbenzene sulfonate represents three-quarters of total anionic production, and the remainder consists of the earlier alkyl aryl sulfonates.

More and more uses for syndets are being found, extending to scouring powders, a greater application by commercial laundries, and more recently in toilet-soap bars. The problems associated with syndet use and disposal can, therefore, be expected to increase.

The analytical method employed in this study for syndet determination is based upon the reaction of an anionic sulfonated surfactant and a colored cation (methylene blue) to form blue double compounds which are soluble in chloroform. Under suitable conditions these compounds can be quantitatively extracted from an aqueous solution without the extraction of any uncombined methylene blue. The amount of syndet may, therefore, be determined from the concentration of colored salt in the chloroform extraction. The concentration of the colored solutions can then be determined by comparison against a series of standards in a comparator.*

* Taylor Syndet Comparator; manufactured by W. A. Taylor & Co., Baltimore, Md.

Since the different syndets vary in equivalent weight and occur in wastes as complex mixtures, the standards for the comparator used in this study are arbitrarily based on sodium lauryl sulfate. It should be borne in mind that this method detects anionic syndets only and that some of the present-day detergents are cationic, nonionic, or mixtures.

Study Procedure

The water supplied for 186 homes was sampled and investigated by Suffolk County Department of Health sanitary inspectors under the direct supervision of a public health engineer. In the area south of the former plating plant and of the Dayton T. Brown Corp. (Fig. 1) the samples were analyzed for hexavalent chromium as well as syndets. The analyses were made by the health department laboratory and the Division of Laboratories and Research of the State Department of Health.

In each home where a sample was collected depth of well, distance to cesspool, and age of house was requested. The information was not available in all instances.

A number of homes in part of the study area were surveyed to discover the location of cesspools and wells on each lot. The results obtained are shown in Fig. 2. The area of this survey is shown by dotted lines in Fig. 1.

Twenty samples from these wells were forwarded to the state health department laboratory for complete chemical analysis. The results of these analyses are given in Table 5.

The study included an evaluation of the amounts of detergents used per home per week in the area. In order to obtain this information a number

of housewives were interviewed and data were furnished by two supermarkets in the area as to sales of detergents.

A limited study was also made to determine the level at which syndets in water caused an objectionable taste to the majority. This was evaluated by questioning homeowners whose wells contained syndets and by a test of prepared solutions of water containing varying concentrations of syndets by 23 persons in the Suffolk County Department of Health.

The results of these various investigations and some of the conclusions drawn from them are discussed in the next section.

Results and Conclusions

The wells of 186 different homes were sampled in this study. In 60

TABLE 2

Relationship of Well Depth and Syndet Concentration

Depth of Well *ft*	Number of Wells	Number of Wells With Syndets	Number of Wells Without Syndets	Wells With Syndets %	Syndet Concentration—*ppm*			
					<0.4	0.4–0.9	0.9–1.4	>1.4
14	1	1		100			1	
15	1		1	0				
17	1	1		100			1	
18	2	1	1	50		1		
20	6	1	5	17		1		
21	1	1		100				1
22	4	3	1	75			3	
25	45	29	16	64	5	16	5	3
28	13	6	7	46	3	1	2	
30	26	11	15	42	2	6	2	1
33	3	2	1	67	2			
35	8	2	6	25			1	1
38	4	1	3	25			1	
40	1		1	0				
50	1	1		100			1	
56	1		1	0				
Totals	118	60	58	50.85*	12	25	17	6

* Average.

of these wells syndets were detected in varying amounts:

Number of Wells	Syndet Concentration ppm	Per Cent of Total Wells
126	0.0	67.7
12	0.1–0.4	6.5
25	0.4–0.9	13.5
17	0.9–1.4	9.1
6	>1.4	3.2

Only 32.3 per cent of the total number of wells sampled contained syndets at the time of sampling. In some instances wells in which no syndets were detected in November 1957 showed the presence of syndets in March 1958. In no case has disappearance or reduction of syndets from a contaminated well been observed.

Depth of Well

The relationship of well depth to amount of syndets present is shown in Table 2. One hundred and eighty-six wells were sampled, but the depth could be reliably determined for only 118 of them. In 58 of these wells no syndets were detected at the time of sampling.

The percentage of wells showing syndets at the various depths has been determined. Review of the data indicates depths ranging from 14 to 56 ft. Syndets were detected at all depths, except for the 15-, 40-, and 56-ft wells. Eighty per cent of the wells were within the 25–35-ft depth. Examination of the results obtained within that range indicates a decrease in the appearance of syndets with increase in well depth:

Well Depth ft	Wells at Depth With Syndets % of total
25	64
30	42
35	25

The intensity range of syndets, however, remains constant at all depths.

It would appear that syndets might be avoided by increasing well depths. Definite conclusions are precluded by a number of considerations:

1. Scarcity of data on wells of greater depths

2. Appearance of syndets in wells as deep as 95 ft in Mastic, in the town of Brookhaven, N.Y., in a survey by C. W. Lauman & Co. in January 1958.

3. Lack of data on relationship of time between application of syndets at point of discharge and ultimate appearance in well.

Although some protection from syndets may be obtained by deepening wells, it is believed that the only gain would be time and that the syndets would ultimately reappear. Experience with wells which have been altered in depth in other locations in Suffolk County substantiates this conclusion.

Distance of Well From Cesspool

The relationship between appearance of syndets and the distance of well from cesspool is shown in Table 3. Examination of these data would indicate that the possibility of the appearance of syndets in wells is about the same for all distances from 35 to 60 ft from cesspools.

Distance from cesspools was accurately determined for 111 of the wells studied. Almost 90 per cent of these wells were less than 65 ft—the minimum distance recommended by the county department of health—from a cesspool. Of the 12 wells 65 ft or more from a cesspool 2 showed traces of syndets; of 99 wells less than 65 ft from a cesspool 46 showed traces of syndets. However, the scarcity of information about wells more than 65 ft from cesspools precludes any defi-

nite conclusions as to the effect of greater distances.

Two further factors cause doubt as to the benefit of increased distances from cesspools:

1. The initial results of a Water Pollution Control Board study in an area contaminated by syndets from a launderette in Mastic, in the town of Brookhaven, N.Y., show traces of syndets 500 ft from their source.

greater distance ranges prevents any definite recommendations as to distance. Relative to direction, it is an obvious conclusion that avoidance of the southerly passage of waste discharges on the south shore of Suffolk County will improve the possibility of avoiding the syndets. This is a precaution which is limited primarily to the plot on which the well and cesspool are located, and avoidance of the

TABLE 3

Relationship of Distance Between Wells and Cesspools and Syndet Concentration

Distance From Cesspool *ft*	Number of Wells	Number of Wells With Syndets	Number of Wells Without Syndets	Wells With Syndets %	Syndet Concentration—*ppm*			
					<0.4	0.4–0.9	0.9–1.4	>1.4
30	4		4	0				
35	5	3	2	60		2	1	
40	38	18	20	47	2	12	3	1
45	4	2	2	50			2	
50	33	15	18	45	3	6	4	2
60	15	8	7	53	1	2	3	2
65	9	2	7	22		2		
70	1		1	0				
80	2		2	0				
Totals	111	48	63	43.25*	6	24	13	5

* Average.

2. Spot-sampling of a realty subdivision in Deer Park, N.Y., where wells and cesspools were installed in conformance with Suffolk County Department of Health standards, showed seven out of the seventeen wells sampled to contain syndets.

It is believed that distance and direction from the cesspool are definite factors in avoiding syndets in wells. Lack of information on wells in the

waste on one plot may place the well directly in the path of the waste from the adjacent plot. The overall movement of the ground water in this area carries all wastes in the southerly direction; hence, selection of a point in some other direction from the source of contamination is possible only with large plots and when there is initial control in the placing of all wells and cesspools.

Effect on Taste of Water

In order to determine at what concentration the syndets create an unpleasant taste in water, two procedures were followed:

1. The housewives in 26 of the affected homes were interviewed relative to the taste of their water. Homes were selected with syndet concentrations in their wells varying from 0.25 to 2.5 ppm. The results of this survey indicated that about 10 per cent of those with syndet concentrations of less than 1.0 ppm reported an off-taste, and all of those with syndet concentrations of 1.5 ppm or more reported an off-taste.

2. Using a standard household detergent, tap water samples were made up containing syndet concentrations varying from 1.0 to 3.0 ppm. A control bottle with no syndets in the water was included in the group. Twenty-three of the staff of the Suffolk County Department of Health were asked to drink the various unmarked samples and comment upon the taste. They were not informed as to the contents, were tested individually, and were requested not to discuss the test with others. The results are given in Table 4.

A review of the results of the second procedure indicates that the majority of those tested began to definitely detect an off-taste at 2.0 ppm. It should also be noted that almost 35 per cent reported taste at 1.0 ppm. The drop at 1.5 ppm and sudden jump back to 34.8 per cent at 1.75 ppm was not explained. Six of those tested reported no taste in any of the samples. The taste was described by various individuals tested as oily, fishy, and frequently as perfume-like.

It must be recognized that the rather wide variance in the ingredients in the various detergents which are on the market makes establishment of a threshold or definition of taste applicable to all syndets difficult. One definite conclusion may be reached from the experience of the Suffolk County Department of Health: the most commonly received complaint relative to individual well supplies is an off-taste and in most such instances syndets are found in the supply. Frothing or foaming of the water is also a common complaint. Most frothing appears at about 1.0 ppm. This also is a feature which varies with the brand of detergent used.

TABLE 4

Relationship Between Syndet Concentration and Taste of Water

Syndet Concentration *ppm*	Off-Taste Reported	No Off-Taste Reported	Off-Taste Reported %
	samples		
0.0	1	22	4.3
1.0	8	15	34.8
1.5	2	21	8.7
1.75	8	15	34.8
2.0	13	10	56.5
2.5	14	9	60.9
3.0	14	9	60.9

Average Syndet Use

In order to determine the amount of syndets used by the average housewife in the area in question:

1. Eight families in the study area were spot-checked to determine the amount they used. The number of persons per family varied from 2 to 6. The check indicated an average use of 2.7 lb per family per week, including liquid and dry detergents.

2. Two supermarkets in the vicinity kept records of the amount of detergents sold. The amount determined

from this procedure varied from 1.3 to 1.7 lb per family per week.

To obtain some picture of the extent of contamination of the ground water by syndets a computation was made. It should be borne in mind that all sewage is returned to the ground by means of individual sewage disposal systems:

2.0 lb syndets per family per week
300 families × 2 lb per family per week = 600 lb per week
600 lb per week × 52 weeks = 31,200 lb per year or 15.6 tons per year

According to this computation approximately 15.6 tons of syndets per year are dumped into the 72 sq acres on which these homes are located.

The findings of detergents in the ground waters from launderette wastes several years after the launderettes have closed up indicates that the detergents do not deteriorate or stabilize to less objectionable compounds. It is known from previous studies that wastes in ground waters tend to remain in concentrated slugs with only a relatively small amount of dilution taking place on the periphery of the slug.

TABLE 5

Chemical Analysis of Water Samples Containing Syndets

Concentration of Syndet in Sample *ppm*	Chemical Constituents—*ppm*									pH
	Iron	Free Ammonia (as N)	Ammonia Albuminoid (as N)	Nitrites (as N)	Nitrates (as N)	Oxygen Consumed (O)	Chlorides (Cl)	Total Hardness (as $CaCO_3$)	Alkalinity (as $CaCO_3$)	
2.40	0.03	12.40	0.460	0.005	30.0	2.5	32.0	66.0	72.0	6.4
2.00	0.45	7.60	0.056	0.008	0.4	1.6	16.0	34.0	46.0	6.4
1.60	0.25	12.80	0.082	0.004	3.0	4.0	35.0	40.0	66.0	6.1
1.50	<0.03	4.80	0.146	0.002	13.0	2.0	28.0	66.0	71.0	6.2
1.30	1.00	2.00	0.094	0.040	0.7	1.5	20.0	50.0	32.0	5.9
1.10	0.15	4.00	0.140	0.005	2.0	1.1	18.0	28.0	26.0	6.0
1.10	0.30	3.54	0.140	0.005	2.0	1.1	16.0	28.0	15.0	5.8
1.00	0.15	5.60	0.212	0.006	0.14	2.5	33.0	40.0	183.0	6.7
0.93	4.00	13.20	0.102	0.100	1.8	1.4	16.0	36.0	63.0	6.3
0.65	0.80	3.50	0.310	0.002	1.7	1.5	14.6	24.0	13.0	5.6
0.63	<0.03	10.40	0.046	0.002	0.7	1.4	24.0	36.0	27.0	5.9
0.55	1.00	2.70	0.080	0.005	1.4	1.5	10.6	12.0	9.0	5.9
0.50	0.60	1.60	0.066	0.002	3.0	1.1	12.2	24.0	14.0	5.7
0.35	4.50	0.56	0.034	0.030	1.7	1.1	15.0	38.0	27.0	6.1
0.28	0.50	0.76	0.016	0.010	2.0	1.1	16.0	38.0	17.0	5.7
0.25	0.30	7.00	0.130	0.008	0.8	2.0	49.0	48.0	85.0	6.6
0.15	0.14	0.016	0.006	0.002	2.0	0.4	34.0	20.0	8.0	5.6
0.05	0.60	1.50	0.040	0.100	2.0	0.8	8.0	30.0	8.0	5.8
<0.05	0.03	0.008	0.002	0.001	0.12	0.5	4.4	8.0	4.0	6.2
≪0.05	0.18	0.012	0.010	0.001	0.36	0.6	8.4	18.0	6.0	5.7

Constituents of Water

Samples from 20 of the wells affected by syndets were forwarded to the state health department for complete chemical analysis. The samples were collected from wells containing syndets in

concentrations varying from less than 0.05 to 2.40 ppm. The results are tabulated in Table 5. A study of the results shows:

Constituent	Concentrations in in Water—*ppm*	
	Syndet-Containing Water	Normal Ground Water
Free ammonia (as N)	3.0– 13.0	< 0.05
Oxygen consumed	1.0– 4.0	< 0.5
Chlorides	15.0– 49.0	<10.0
Alkalinity	30.0–180.0	<15.0

The presence of nitrogen constituents (free ammonia) and chlorides in unusually high amounts has long been recognized as an indicator of water of poor sanitary quality. The chemicals examined, however, have been chemicals normally present in ground water, although in smaller quantities. The syndets are not normally present and can originate only from the discharge of sewage. The presence of syndets in a well is proof, therefore, of its accessibility to a sewage discharge. The unusually high amounts of those chemicals indicative of organic contamination in the presence of syndets substantiates the sewage origin of the waste.

General Conclusions

As a result of this study a number of general conclusions can be drawn:

1. When individual wells and sewage disposal systems are placed on relatively small plots it may be anticipated with some certainty that syndets will appear in the well.

2. Increased depths of wells and distances from cesspools may delay, but it is certain will not prevent the appearance of syndets in well water.

3. The presence of syndets in water causes unpleasant taste and frothing. Most persons detect the taste when the syndet concentration is 1.5 ppm or higher.

4. The average homeowner may add 100 lb of syndets to the ground water each year. These syndets do not appear to deteriorate and the wastes tend to remain concentrated with little dilution. With continued addition of syndets year after year, the amount will build up and the problem will become more acute each year.

5. Syndets originate only in sewage discharges and their presence in well water definitely establishes contamination by the homeowner's own sewage or his neighbors'.

6. The significance of syndets as a vehicle to transport bacteria, viruses, or other pollutants greater distances than they might normally travel is unknown.

7. The phosphates present in most detergents may enhance the medium for bacteria in ground water and thereby increase their numbers and survival time.

8. There appears to be little information available relative to the toxicity of syndets.

Recommendations

The means which are recommended for solving the problems caused by syndets in water are in some instances obviously determined, but are not so easily effected:

1. Existing public water supplies should be extended or new supplies formed to serve presently affected areas and proposed housing developments. This is particularly important in those areas where high plot densities (3½–6 homes per acre) preclude any possibility of minimizing contamination. Extensive areas in southwestern Suffolk County have private wells and cesspools on small plots. In many instances the Suffolk County Water Authority's mains are relatively close, but the authority's expansion policies

make extension into these areas difficult. Formation of town public water supply districts would be more easily accomplished. However, to have the two agencies performing the same function in such close proximity would appear to be undesirable from a planning standpoint. It is strongly recommended that the authority's expansion policies and enabling legislation be reviewed and altered, if necessary, to permit more liberal expansion policies.

2. The depth of wells should be increased to a minimum of 50 ft below grade and 40 ft into the water-bearing strata. Wells should be placed a minimum of 100 ft from cesspools, and as nearly as possible aside from the flow of sewage into the ground water. This recommendation applies only when public water supplies are determined to be economically impossible and plot density is more than two homes per acre. Even if this recommendation is put into effect, however, it is believed that the only benefit derived will be a time delay in the appearance of syndets.

3. The manufacturers of syndets should possibly alter the nature of the product so as to eliminate its undesirable features. This will not eliminate, however, the sewage which carries the syndets to the well point. The thought also arises that even if syndets are eliminated there is no way of predicting what may next appear in ground water. Present and future chemical products employed as cleaners, weed killers, and soil conditioners will, if water soluble, eventually seep into the ground water.

4. The water from the Glacial strata in lightly populated areas may be assumed to be a safe potable supply. It does not appear, however, that such safety can be assumed in the more populous and industrialized areas. Contamination by industrial wastes, sewage, and syndets is extensive enough to offset what little benefit is gained from dilution. It would appear that in such areas the deeper strata must be explored for public water supplies. It must also be recognized that if wells and cesspools are placed in the shallow strata in these heavily populated areas contamination of wells is inevitable.

5. As pointed out in the report of the Suffolk County Department of Health on industrial waste contamination of ground water supplies, there must be a continuing program of evaluating ground water quality in order to detect any deterioration. Such a program could be logically incorporated in a program which would also record by a systematic method the rise, fall, and movement of the ground water table of Suffolk County.

Determination of Orthophosphate, Hydrolyzable Phosphate, and Total Phosphate in Surface Waters

AASGP Committee Report

A contribution to the Journal by the Subcommittee on Phosphates, Tech. Advisory Com., Assn. of Am. Soap & Glycerine Producers, Inc., New York, submitted by H. V. Moss (Chairman), Director, Product Quality, Inorganic Chemicals Div., Monsanto Chemical Co., St. Louis, Mo. Other members of the subcommittee are L. E. Netherton, H. J. Weiser, C. F. Callis, C. E. Johnson, Daniel Lundgren, J. J. Morgan, R. W. Ockershausen, Edgar Paulson, William Preusse, John Ross, T. W. Schilb, M. V. Trexler, H. R. Tyler, and P. J. Weaver.

THE Association of American Soap & Glycerine Producers, New York, initiated a research program in 1955 to study the traces of detergents which may find their way into rivers and public water supplies through domestic use of household detergents. A group of qualified technical representatives from industry was organized as the Technical Advisory Subcommittee on Phosphates as a part of this program. One of the primary objectives of this subcommittee was to develop reliable analytical methods for determining trace amounts of orthophosphates and inorganic condensed phosphates in natural surface waters.

The methods currently used for determining orthophosphate and condensed phosphates (*1*) require that a colorimetric orthophosphate determination be run on the surface water sample before and after acid hydrolysis. This method was found to give erroneous results because: [1] partial hydrolysis of the condensed phosphates during the orthophosphate determination gives high orthophosphate and low condensed phosphate values, and [2] interference is encountered from a number of materials commonly found in surface waters.

Another significant weakness in the current method which was uncovered through the work of the subcommittee is the inability properly to account for the P_2O_5 originating from organic compounds in the sample. The most probable source of such phosphorus-containing organic compounds is naturally occurring microorganisms. It was conclusively demonstrated by the subcommittee's work that the simple acid hydrolysis will pick up P_2O_5 from the hydrolysis of P-O-P bonds in organic compounds, but will not give the total P_2O_5 of the sample when P_2O_5 is bound in the organic molecule through P-O-C or P-C bonding.

A. Description of Recommended Method

1. General Discussion

1.1. *Principle.* The method recommended by the subcommittee, and proved by collaborative analyses in ten industrial laboratories, makes use of a suitably modified extraction and hydrolysis procedure based on the technique originally published by Martin and Doty (*2*).

a. The danger of hydrolysis of the condensed phosphates is eliminated in the ortho determination because the contact time of the acid solution with the sample is reduced to 60–90 sec.

b. The extraction step also effectively eliminates interference by other ions.

1.2. *Scope*

a. The method can be used to determine the orthophosphate, hydrolyzable, and total P_2O_5 content of surface water, at levels as low as a fraction of a part per million. Orthophosphate P_2O_5 is obtained by running the colorimetric extraction determination on the original sample. Orthophosphate may be present: [1] as a result of hydrolysis of condensed phosphates, [2] from soil leaching, [3] from mineral phosphates, or [4] from original orthophosphates stemming from wastes. Hydrolyzable P_2O_5, either from inorganic condensed phosphates or from organic compounds which have condensed phosphate groups, is obtained by boiling the sample in aqueous acid, running the colorimetric determination, and subtracting the previously determined orthophosphate P_2O_5 value from the result. Total P_2O_5, which also includes all P_2O_5 in organic compounds, is determined by wet ashing the sample and running the colorimetric determination.

b. Procedures are presented for samples containing 0.6–32 ppm total P_2O_5 and for samples containing 0.05–0.6 ppm total P_2O_5. The first procedure can be used for samples with concentrations greater than 32 ppm total P_2O_5, if suitably diluted.

c. At times it is desirable to distinguish soluble from insoluble phosphates. This can be done by analyzing the surface water sample as is and then analyzing another portion after filtering through a 600-ml, medium-porosity fritted glass funnel.

Natural water samples should be analyzed as soon as practical after being collected because hydrolytic and biological reactions will change the values, as has been proved by Karl-Kroupa, Callis, and Seifter (*4*).

2. Apparatus

All glassware must be carefully washed, rinsed well with tap water, and then rinsed at least three times with distilled water.

2.1. *Spectrophotometer or electrophotometer,* red filter, wavelength approximately 620–630 mμ, optical cells with light path of 20–25 mm.

2.2. *Automatic pipet,* calibrated, 50-ml capacity, with reservoir, connections of plastic tubing not affected by benzene or of glass.

2.3. *Pipets,* calibrated, 25 ml, 10 ml, 5 ml.

2.4. *Safety aspirator* *

2.5. *Graduated extraction cylinders,* 100 and 500 ml, with well-fitting, ground-glass stoppers.

2.6. *Volumetric flasks,* 50 ml.

2.7. *Beakers,* 250 and 400 ml.

2.8. *Hot plate,* rheostat-controlled.

2.9. *Glass beads or Hengar granules,* 1–2 mm diameter.

* The safety aspirator used in these tests was the "Propipet," manufactured by Will Corp., Rochester, N.Y.

2.10. *Graduated cylinders,* 50 and 25 ml.

2.11. *Wet-ashing apparatus* (Fig. 1):

a. Erlenmeyer flask, 500 ml with a standard taper 24/40 joint.

b. Safety flask, 500-ml filter flask.

c. Glass tubing. The connecting tubing of the wet-ashing equipment must be *all* glass. No rubber or plastic tubing should be used.

3. Reagents

3.1. *Potassium phosphate,* monobasic, anhydrous, ACS (American Chemical Society) reagent grade. Dry at 110°C for 1 hr. Cool in a desiccator prior to weighing.

3.2. *Sulfuric acid,* 8*N*. Dilute 222 ml, concentrated, ACS reagent grade, sp gr 1.84 to 1 liter with distilled water.

3.3. *Ammonium molybdate solution,* neutral, 10 per cent. Dissolve 100 g of $(NH_4)_6MO_7O_{24}\cdot 4H_2O$, ACS reagent grade and dilute to 1 liter with distilled water. Store in brown, stoppered bottles.

3.4. *Acidic molybdate reagent.* Equal volumes of sulfuric acid (3.2) and ammonium molybdate solution (3.3) are mixed. Store in stoppered bottles.

3.5 *Benzene-isobutanol solvent.* Equal volumes of benzene and isobutanol, both ACS reagent grade, are mixed.

3.6. *Stock stannous chloride solution.* Ten grams of $SnCl_2\cdot 2H_2O$ are dissolved in 25 ml of concentrated HCl, both ACS reagent grade. Solution should be freshly prepared every 2 weeks and stored in a dark, stoppered bottle.

3.7. *Sulfuric acid,* 1*N*. Dilute 27.7 ml, concentrated, ACS reagent grade, sp gr 1.84 to 1 liter with distilled water.

3.8. *Diluted stannous chloride solution.* Add 0.5 ml of stannous chloride solution (3.6) to 100 ml sulfuric acid (3.7). Prepare daily.

3.9. *Methyl alcohol,* ACS reagent grade.

3.10. *Alcoholic sulfuric acid,* 20 ml, concentrated, ACS reagent grade, sp gr 1.84. Mix with 980 ml of methyl alcohol with adequate stirring.

3.11. *Nitric acid,* concentrated, cp, meeting ACS specifications.

3.12. *Sodium hydroxide,* 10 per cent solution in water.

3.13. *Perchloric acid,* 60–62 or 70–72 per cent, meeting ACS specifications.

The usual stringent precautions in handling perchloric acid should be observed to prevent explosions. If the solution begins to darken or char an explosion is imminent. Remove from heat immediately and add several milliliters of concentrated HNO_3 at once. After effervescence ceases continue heating.

The use of perchloric acid can be avoided by adding 6.0 ml of concentrated H_2SO_4 to 10 ml concentrated HNO_3 and boiling down to fumes of SO_3. Two more 10-ml additions of HNO_3 must be made and removed by fuming to insure complete decomposition of the organic phosphates. Cool to room temperature and cautiously add 60 ml of water. Boil for 25 min.

4. Procedure

4.1. *Preparation of calibration curve.* Dissolve 0.1917 g KH_2PO_4 in 1 liter of distilled water. This standard solution (Std. 1) contains 0.1 mg (100 μg) P_2O_5 per milliliter. Dilute 50 ml of this solution to 1 liter to obtain standard solution (Std. 2) which contains 5 μg (0.005 mg) P_2O_5 per milliliter. Pipet 5-, 10-, 20-, and 30-ml aliquots of standard solution (Std. 2) into separate 100-ml graduated extraction cylin-

ders and dilute to 40 ml with distilled water. Add exactly 50 ml of the benzene-isobutanol mixture from an automatic pipet. Measure 15 ml (±0.1 ml) of the acidic molybdate reagent in a 25-ml graduate, pour it into the 100-ml graduated extraction cylinder containing the sample and the organic solvent, close immediately, and shake vigorously without delay for exactly 15 sec. (The time must be watched carefully when analyzing mixtures of orthophosphates and condensed phosphates.

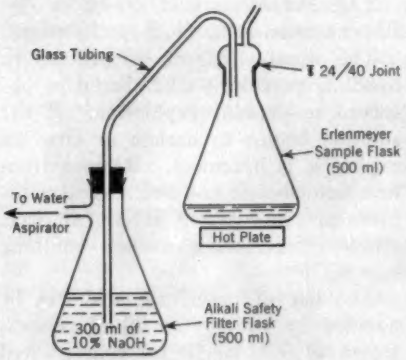

Fig. 1. Wet-Ashing Apparatus

This apparatus consists of two 500-ml flasks, connected by glass tubing. The top section is a wash bottle top with the siphon arm cut off and the outside arms modified.

Considerable error could be caused by hydrolysis of condensed phosphates.) Remove the stopper of the graduated extraction cylinder and, as soon as the layers have separated, withdraw a 25-ml aliquot of the supernatant organic solvent with a calibrated 25-ml pipet, using a safety aspirator. Transfer the aliquot into a 50-ml volumetric flask, add about 15 ml alcoholic sulfuric acid, and swirl. Add 1 ml diluted stannous chloride solution, swirl, and make to the mark with alcoholic sulfuric acid. Mix well and allow to stand 10 min before reading optical density or percentage transmission. Measure within 30 min against the blank. Set up the calibration curve by plotting micrograms P_2O_5 against the optical density or percentage transmission.

4.2. *Procedure for samples containing more than 0.6 ppm total* P_2O_5

a. Analysis for orthophosphate P_2O_5. Transfer an appropriate volume of the sample into a 100-ml graduated extraction cylinder:

Expected Total Concentration *ppm*	Aliquot Size *ml*
0.6– 4	40
4–16	10
16–32	5

Dilute to 40 ml with distilled water. Place 40 ml of distilled water in another 100-ml graduated extraction cylinder as a blank and carry it through the whole procedure with the sample as described in Sec. 4.1.

b. Analysis for hydrolyzable P_2O_5 *plus orthophosphate* P_2O_5. Add 8 ml of 8*N* sulfuric acid to an appropriate aliquot (see *a*) and dilute to 48 ml with distilled water in a 250-ml beaker. Add two Hengar granules, or several glass beads, to avoid bumping, cover with a close-fitting, nonribbed watch glass, and boil gently for 40 min. Do not evaporate to dryness. Add 8 ml of 8*N* sulfuric acid to 40 ml distilled water in another 250-ml beaker and carry it through the whole procedure as a blank. After cooling, transfer the acid solution into a 100-ml graduated extraction cylinder and rinse the beaker and granules, or beads, with a few milliliters of water. Make up to 48 ml with distilled water. Add exactly 50 ml benzene-isobutyl alcohol mixture and 8 ml neutral (10 per

cent) ammonium molybdate solution. Stopper the cylinder and shake vigorously for at least 15 sec. In this procedure extension of the shaking period does not affect the result since all reversion of the hydrolyzable P_2O_5 has been completed in the preceding hydrolysis step. The analysis is completed as described in Sec. 4.1.

c. Analysis for total P_2O_5. Place an appropriate sample (see *a*) in the 500-ml Erlenmeyer flask of the wet-ashing apparatus. Add 10 ml concentrated nitric acid, 25 ml of 60–62 per cent perchloric acid or 21 ml of 70–72 per cent perchloric acid (Sec. 3.13) and two Hengar granules, or several glass beads (*1*). Place 40 ml distilled water, 10 ml concentrated nitric acid, 25 ml of 60–62 per cent perchloric acid as used for the sample and two Hengar granules, or several glass beads, in another flask and carry it through the procedure as a blank. Boil the sample down to about 40 ml. Place the tube from the flask containing 300 ml of 10 per cent sodium hydroxide (see Fig. 1) in the neck of the sample flask and turn on the water aspirator. Continue boiling until all the nitric acid is driven off and dense white fumes of perchloric acid begin to evolve (Sec. 3.13) (*2*). Continue heating for 2–4 min after all HNO_3 is driven off. Cool the sample to room temperature and carefully add 60 ml distilled water. Transfer to a 500-ml extraction cylinder. Rinse the flask several times with distilled water and drain the washings into the cylinder. Dilute the sample to 225 ml with distilled water. Add 17 ml of isobutanol, carefully measured in a 25-ml graduated cylinder, and mix. Add exactly 50 ml of the benzene-isobutanol mixture from an automatic pipet and add 25 ml of neutral molybdate reagent, measured in a 25-ml graduated cylinder. Stopper the cylinder and shake vigorously for 1 min. Allow the layers to separate and transfer 25 ml of the supernatant organic layer to a 50-ml volumetric flask. Complete the determination as described in Sec. 4.1.

4.3. *Procedure for samples containing 0.05–0.6 ppm total P_2O_5.*

a. Analysis for orthophosphate P_2O_5. Transfer 200 ml of the water sample to a 500-ml graduated extraction cylinder. Place 200 ml of distilled water in another cylinder and carry through the procedure to obtain a blank. Add 17 ml, carefully measured in a 25-ml graduated cylinder, of isobutanol, stopper cylinder, and mix until dissolved. Add 50 ml of the benzene-isobutanol mixture from an automatic pipet. Measure 50 ml acidic molybdate reagent in a 50-ml graduated cylinder, pour it into the 500-ml extraction cylinder, stopper the cylinder, and immediately shake vigorously for 1 min. As soon as the layers separate, transfer a 25-ml aliquot of the supernatant organic layer to a 50-ml volumetric flask. Complete the procedure as described in Sec. 4.1.

b. Analysis for hydrolyzable P_2O_5 plus orthophosphate P_2O_5. Transfer 200 ml of the water sample to a 400-ml beaker. Add 25 ml of 8*N* sulfuric acid, two Hengar granules, or several glass beads, to prevent bumping, and boil gently for 40 min. Do not allow to evaporate to dryness. Place 200 ml distilled water in another 400-ml beaker and carry through the procedure as a blank. After cooling, transfer the solution to a 500-ml graduated extraction cylinder, rinse the beaker and granules, or beads, with distilled water, and dilute the sample to 225 ml with distilled water. Continue as described in Sec. 4.2.*c*.

TABLE 1

Analyses of Distilled-Water Solutions

Property	Determination Made*							
	Ortho				Ortho + Hydrolyzable			
	1	2	3	4	1	2	3	4
Solution A†								
P_2O_5 found—*ppm*	1.052	1.060	0.0543	0.0546	2.022	1.990	0.102	0.103
P_2O_5 added‡—*ppm*	1.048	1.048	0.0524	0.0524	1.970	1.970	0.0990	0.0985
Recovery—%	100.3	101.1	103.6	104.1	102.6	101.0	103.1	104.9
Standard deviation§:								
ppm	0.038	0.059	0.0041	0.0048	0.060	0.072	0.010	0.011
% of added value	3.7	5.7	7.8	9.2	3.1	3.6	10.3	11.5
Diluted Solution A‖								
P_2O_5 found—*ppm*	5.07	2.58	0.639	0.069	20.02	10.03	2.51	0.245
P_2O_5 added—*ppm*	5.09	2.54	0.636	0.064	19.69	9.84	2.46	0.246
Recovery—%	99.6	101.3	100.2	109.3	102.0	102.0	101.9	99.6
Standard deviation§:								
ppm	0.10	0.07	0.027	0.011	0.14	0.14	0.019	0.005
% of added value	1.9	2.9	3.8	17.0	0.7	1.2	0.8	2.0

Solution B#

	Ortho	Ortho + Hydrolyzable	Total P_2O_5
P_2O_5 found**—*ppm*	0.624	1.220	1.490
P_2O_5 added††—*ppm*	0.626	1.200	1.480
Recovery—%	99.7	101.6	100.7
Standard deviation‡‡:			
ppm	0.021	0.100	0.051
% of added value	3.4	8.6	3.4

* Results for 1 and 3 are averages of duplicate determinations on the same day. Results for 2 and 4 are single determinations on a different day.

† Solutions prepared from ACS reagent grade KH_2PO_4 and $NP_3O_7 \cdot 10H_2O$, plus a laboratorys ample of $Na_4P_2O_{10} \cdot 6H_2O$ and commercial sodium hexametaphosphate. Summary of results from ten laboratories.

‡ Ortho content was based upon the theory for KH_2PO_4 and upon chromatographic analyses of the other three salts employing higher concentrations of the sample on the paper than given in the original procedure (*3*). Ortho plus hydrolyzable content is based upon theory for KH_2PO_4 and $Na_4P_2O7 \cdot 10H_2O$ and upon colorimetric analyses for the P_2O5 content in the other two salts.

§ For each determination there was one deviant laboratory.

‖ Prepared from the same chemicals as used in Solution A, diluted to widely varying levels; summary of results from eight laboratories.

\# Containing ACS reagent grade KH_2PO_4 plus adenosine triphosphate (disodium salt, tetrahydrate, 99 per cent assay); summary of results from ten laboratories.

** Each laboratory ran duplicate determinations.

†† Assuming theoretical compositions for the two materials, and that two-thirds of the P_2O_5 content of adenosine triphosphate is found in the hydrolyzable P_2O_5 analysis.

‡‡ For the determination of ortho plus hydrolyzable there was one deviant laboratory; for the other two determinations there were none.

c. Analysis for total P_2O_5. Place 200 ml of the sample in the 500-ml Erlenmeyer flask (Fig. 1) of the wet-ashing apparatus. Continue as described in Sec. 4.2.*c*.

5. Calculations

5.1. *Orthophosphate* P_2O_5 (mg/l)

$$= \frac{P_2O_5 \text{ from calibration curve } (\mu g)}{\text{sample (ml)}}$$

5.2. *Hydrolyzable* P_2O_5 (mg/l)

$$= \frac{P_2O_5 \text{ from calibration curve } (\mu g)}{\text{sample (ml)}} - \text{ortho } P_2O_5 \text{ (mg/l)}$$

5.3. *Total* P_2O_5 (mg/l)

$$= \frac{P_2O_5 \text{ from calibration curve } (\mu g)}{\text{sample (ml)}}$$

5.4. *Amount* of PO_4 (mg/l)

$$= P_2O_5 \text{ (mg/l)} \times 1.34$$

B. Evaluation of the Method

1. Collaborative Analyses

1.1. *Distilled water.* The results of collaborative analyses of distilled-water solutions for ortho, ortho plus hydrolyzable, and total phosphate are given in Table 1. It is concluded from the data in this table that the method under investigation is basically sound and capable of determining phosphates with a satisfactory degree of precision.

1.2. *Natural water.* Results of two collaborative series, one in 1956 and one in 1957, are summarized in Table 2. The work included analysis of natural waters selected from local sources near the individual collaborators, before and after filtration to remove suspended solids. With one exception the total phosphate content was uniformly less than 1.0 ppm and the hydrolyzable phosphate was less than 0.5 ppm. It should be borne in mind that, throughout these tests, "hydrolyzable" did not represent only inorganic complex phosphates. Suspended material in these samples contained significant amounts of P_2O_5, possibly in the form of water-insoluble phosphates, or phosphates adsorbed on the suspended material.

1.3. *Natural water with phosphates added.* The method was further tested in another collaborative series of analyses, summarized in Table 3, in which inorganic and organic phosphates were added to natural waters at two concentration levels. Adenosine triphosphate was used as the source of organic P_2O_5 because it represents the type of compound that can be encountered in surface waters and is obtainable in pure form. Since adenosine triphosphate contains two P-O-P bonds and one P-O-C bond, simple acid hydrolysis should pick up two-thirds of the P_2O_5 and wet ashing the remainder. It should be realized that P-O-P bonds, whether in inorganic or organic compounds, are hydrolyzable and will appear in the simple acid hydrolysis step.

1.4. *Conclusions from analyses*

a. The wet-ashing procedure accounts for all of the P_2O_5.

b. Simple acid hydrolysis will pick up P_2O_5 from the hydrolysis of P-O-P bonds in organic compounds. If conditions during simple acid hydrolysis are too severe—if, for example, the acidified solution is boiled to near-dryness while heating—some P_2O_5 may also be picked up from hydrolysis of P-O-C bonds in organic compounds.

c. Interferences are rarely encountered in analyses of surface waters (but see Table 2, footnote ‖).

TABLE 2

Phosphate Content of Raw Water

Source of Sample and Date Collected	Turbidity	Phosphate Content (P_2O_5)*—*ppm*			
		Ortho	Hydrolyzable†	Other‡	Total
Kankakee R., Joliet, Ill.					
Apr. 26, 1956	none				
Unfiltered		0.09	0.02	—§	—
Filtered		0.10	0.01	—	—
Feb. 12, 1957	none				
Unfiltered		0.15	0.06	0.10	0.31
Filtered		0.14	0.05	0.05	0.24
Kankakee R., Kankakee, Ill.					
Jun. 6, 1956	high				
Unfiltered		0.11	0.28	—	—
Filtered		0.12	0.11	—	—
Feb. 11, 1957	slight				
Unfiltered		0.054	0.25	0.00	0.30
Filtered		0.040	0.09	0.00	0.13
Rockaway River, Rockaway, N.J.					
Mar. 11, 1957	none				
Unfiltered		<0.1	≪0.1	≪0.1	<0.1
Filtered		<0.1	≪0.1	≪0.1	<0.1
Water Supply, Champaign, Ill.					
Feb. 22, 1957	slight				
Unfiltered		0.21	0.03	0.00	0.18
Filtered		0.08	0.03	0.00	0.08
Oradell Res., Oradell, N.J.					
Feb. 25, 1957	slight				
Unfiltered		0.04	0.04	0.05	0.13
Filtered		0.03	0.04	0.03	0.10
Mad R., Dayton, Ohio					
Jul. 13, 1956	slight				
Unfiltered		0.05	0.01	—	—
Filtered		0.02	0.00	—	—
Apr. 29, 1957	slight				
Unfiltered		0.51	0.14	0.03	0.68
Filtered		0.45	0.03	0.07	0.55
Chicago Water Supply					
Feb. 25, 1957	none				
Unfiltered		0.003	0.01	0.00	0.01
Filtered		0.00	0.00	0.00	0.003

* Average of two determinations.
† Hydrolyzable calculated by subtracting ortho content from ortho-plus-hydrolyzable content (not shown).
‡ Other phosphate content calculated by subtracting ortho-plus-hydrolyzable content (not shown) from total phosphates.
§ Throughout this table dashes indicate that no determination was made.

TABLE 2—*Phosphate Content of Raw Water (contd.)*

Source of Sample and Date Collected	Turbidity	Phosphate Content (P_2O_5)*—*ppm*			
		Ortho	Hydrolyzable†	Other‡	Total
Ohio R., Cincinnati, Ohio					
Jun. 12, 1956	muddy				
Unfiltered		0.12	0.49	—	—
Filtered		0.006	0.10	—	—
Feb. 12, 1957	muddy				
Unfiltered		0.12	0.30	0.23	0.65
Filtered		0.022	0.09	0.03	0.14
James R., Richmond, Va.					
Jun. 14, 1956	none				
Unfiltered		0.041	0.003	—	—
Filtered		0.041	0.003	—	—
Mar. 26, 1957	slight				
Unfiltered		0.053	0.03	0.01	0.090
Filtered		0.021	0.03	0.01	0.060
Millstone R., Boundbrook, N.J.‖					
Feb. 19, 1957	slight				
Unfiltered		0.18	0.06	0.04	0.28
Filtered		0.16	0.05	0.03	0.24
Allegheny R., Pittsburgh, Pa.					
Jul. 31, 1956	slight				
Unfiltered		0.41	0.25	—	—
Filtered		0.25	0.30	—	—
Des Plaines R., Joliet, Ill.#					
Apr. 26, 1956	muddy				
Unfiltered		3.48	0.67	—	—
Filtered		1.68	0.15	—	—
Water Supply, New Milford, N.J.					
Sep. 11, 1956	slight				
Unfiltered		0.031	0.04	—	—
Filtered		0.011	0.02	—	—
Passaic R., Little Falls, N.J.					
Sep. 10, 1956	slight				
Unfiltered		0.46	0.19	—	—
Filtered		0.14	0.01	—	—
Average root-mean-square deviations as percentages of the individual average values		3.3**			2.6††

‖ On an earlier sample (Jun. 11, 1956) from the Millstone R., interference was encountered in the recovery of added phosphate. A later sample (Jul. 2, 1957), taken at approximately the same season of the year during which interference was previously found, gave no interference. The cause for interference in the sample taken Jun. 1956 was not resolved. If interference is suspected, the recovery of added phosphate should be determined to verify possible interference.

American Institute of Laundering discharges waste into river above sample point.

** Results on unfiltered Chicago water and filtered New Milford, N. J., water are not included, because of excessive deviation between determinations. This deviation, although high from the point of view of percentage, is less than experimental error.

†† Results on unfiltered Dayton, Ohio, water are not included, because of excessive deviation between determinations. This deviation, although high from the point of view of percentage, is less than experimental error.

d. The phosphate in surface waters is present largely as orthophosphate.

e. Filtration generally lowers total P_2O_5, especially in muddy water. Measurable organic P_2O_5 appears to be present in the mud.

2. Measures of Precision

2.1. *Statistical measures of dispersion.* Two statistical measures of dispersion of the results are given in the tables in terms of standard deviation (Tables 1 and 3) and root-mean-square deviation (Table 2).

a. Standard deviation. Standard deviation (σ) serves the purpose of portraying the extent of dispersion of the observations in the same units as the original data. It was computed from the relation:

$$\sigma = \sqrt{\frac{\Sigma (X - \bar{X})^2}{N - 1}}$$

where:

Σ = sum of
X = an individual analytical value
$\bar{X}$ = arithmetical average of all the values
N = number of individual values included in the data

On the common assumption that the values possess a standard normal (Gaussian) distribution the standard deviation further makes it possible to

TABLE 3

Recovery of P_2O_5 Added to Surface Water

Property	Ortho				Ortho + Hydrolyzable				Total	
	Unfiltered		Filtered		Unfiltered		Filtered		Unfiltered	Filtered
Solution A*										
	1	2	1	2	1	2	1	2		
P_2O_5 recovered†—*ppm*	1.059	0.044	1.044	0.052	2.007	0.070	1.967	0.084	—	—
P_2O_5 added†—*ppm*	1.048	0.0524	1.048	0.0524	1.970	0.0985	1.970	0.0985	—	—
Recovery of added P_2O_5—%	101.0	84.0	99.6	99.2	102.0	71.4	110.0	85.6	—	—
Recovery of original plus added—%	100.9	99.7	100.4	100.8	102.5	99.1	99.4	94.8	—	—
Standard deviation‡:										
ppm	0.094	0.009	0.087	0.015	0.034	0.037	0.098	0.029	—	—
% of added value	9.0	18.0	8.3	28.0	1.7	38.0	5.0	29.0	—	—
Solution B§										
P_2O_5 recovered—*ppm*	0.648		0.637		1.23		1.23		1.48	1.47
P_2O_5 added—*ppm*	0.626		0.626		1.20		1.20		1.48	1.48
Recovery of added P_2O_5—%	103.3		101.7		102.5		102.5		100.0	99.2
Standard deviation‖:										
ppm	0.052		0.027		0.120		0.130		0.058	0.068
% of added value	8.2		4.3		10.0		10.7		3.9	4.6

* Water spiked with chemicals used in Solution A, Table 1. Summary of results from eight laboratories, each of which ran duplicate tests.

† Ortho content was based upon the theory for KH_2PO_4 and upon paper chromatographic analyses of the other three salts employing higher concentrations of the sample on the paper than given in the original procedure (*3*) Ortho plus hydrolyzable content is based upon the theory for KH_2PO_4 and $Na_4P_2O_7 \cdot 10H_2O$ and upon colorimetric analyses for the P_2O_5 content in the other two salts.

‡ For each determination there was one deviant laboratory. This does not include the Millstone R. sample for June 1956 (see Table 2, footnote §).

§ Water spiked with chemicals used in Solution B, Table 1. Summary of results from ten laboratories.

‖ There was one deviant laboratory each for ortho plus hydrolyzable, unfiltered and filtered. There were no deviant laboratories for the ortho and total determinations.

estimate to what degree an observation may be duplicated and, in this case, the precision of the analytical method. On this basis it can be estimated that:

99.73 per cent of the values will fall within $\pm 3\sigma$
95.45 per cent of the values will fall within $\pm 2\sigma$
68.27 per cent of the values will fall within $\pm 1\sigma$

Thus, it can be estimated that approximately 95 per cent of the time

TABLE 4

Average 95 Per Cent Confidence Limits of the Method

P_2O_5	Phosphate Added *ppm*	Average σ*	Average 95% Confidence Limits	
			ppm	*% of level found*
Phosphates Added to Distilled Water—Summarized From Table 1				
Ortho†	0.05	0.007	±0.014	±28.0
	0.50	0.024	±0.048	± 9.6
	1.00	0.049	±0.098	± 9.8
	2.50	0.070	±0.140	± 5.6
	5.00	0.100	±0.100	± 2.0
Ortho plus Hydrolyzable	0.10	0.011	±0.02	±20.0
	0.25	0.005	±0.01	± 4.0
	2.00	0.066	±0.13	± 6.5
	2.50	0.019	± 0.04	± 1.6
	10.00	0.140	±0.28	± 2.8
	20.00	0.140	±0.28	± 1.4
Total	1.50	0.050	±0.10	± 7.0
Phosphate Found in Surface Waters—Summarized From Table 2				
Ortho	—	±3.3†	—	±4.6
Ortho plus Hydrolyzable	—	±5.9†	—	±9.2
Total	—	±2.6†	—	±3.6
Phosphates Added to Unfiltered Surface Water—Summarized From Table 3				
Ortho‡	0.05	0.009	±0.018	±36.0
	0.50	0.052	±0.100	±20.0
	1.00	0.094	±0.190	±19.0
Ortho plus Hydrolyzable‡	0.10	0.037	±0.07	±70.0
	1.20	0.120	±0.24	±20.0
	2.00	0.034	±0.07	± 3.5
Total‡	1.50	0.058	±0.12	± 8.0

* Average standard deviations are computed from the variance of individual σ:

$$\text{Average } \sigma = \sqrt{\frac{\sigma a^2 + \sigma b^2 + \sigma c^2}{n}}$$

where: σa, σb, σc = individual standard deviations, and n = number of standard deviations included.
† Average root-mean-square deviations, expressed as percentages of the individual average values.
‡ The values for phosphate added are approximate.

an observation (in this case an analytical determination) should fall within plus or minus two times the computed standard deviation ($\pm 2\ \sigma$).

b. Root-mean-square deviation. Root-mean-square deviation (RMS) serves to express dispersion around a central tendency of differences between pairs of observations. It was computed from the relation:

$$\text{RMS} = \frac{\sqrt{\frac{(\text{1st value} - \text{2nd value})^2}{2}}}{\text{average of the pairs}}$$

Employing RMS, it can be estimated that 95 per cent of the time the results should fall within plus or minus 1.4 times the RMS deviation (± 1.4 RMS).

2.2. Precision of the method.

a. Distilled water. Measures of precision summarized in Table 4 show that in distilled water the three varieties of phosphates can be determined within ± 10 per cent of the true value at levels of approximately 0.2–1.0 ppm. As the phosphate concentration increases, precision in terms of percentage of the true value improves and at 20 ppm phosphate in solution, 95 per cent confidence limits are in the order of ± 1–2 per cent of the true value. At concentrations of less than 0.1 ppm phosphate in solution precision drops to roughly ± 20–30 per cent of the phosphate in solution, although in absolute terms 95 per cent confidence limits are in the range of ± 0.01 ppm for ortho P_2O_5 and ± 0.02 ppm for ortho plus hydrolyzable.

b. Unfiltered surface water. In unfiltered surface waters analytical imprecision is significantly greater than in distilled water solutions. Determination of ortho plus hydrolyzable is the least accurate at low phosphate levels. In the range of 0.5–1.0 ppm phosphate in solution, 95 per cent confidence limits are in the order of ± 20 per cent of the true value. At 1.5–2.0 ppm precision improves; at less than 0.1 ppm precision declines. In such low phosphate concentrations the 95 per cent confidence limits for determination of ortho P_2O_5 are in the order of ± 0.02 ppm and for ortho plus hydrolyzable ± 0.07 ppm.

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Case for Uniform Certification

Charles V. Wright and George W. Burke Jr.

A contribution to the Journal by Charles V. Wright, San. Engr., and George W. Burke Jr., Chief, both of the Water Supply Section, Water Supply and Pollution Control Program, USPHS, Washington, D.C.

CERTIFICATION of operators in the American water supply industry has progressed steadily since the first state certification program began in New Jersey in 1919. By 1938 only ten state programs had been established, but this number had more than doubled by 1953, when 23 programs were reported by AWWA (*1*). According to an unpublished USPHS survey, by 1957 the total had swelled to 28 state programs, representing about three-fourths of the national population. With the certain prospect of continued population growth, industrial development, and increasing urbanization, the problems of water supply can only become more complex and the demand for qualified operation more critical. As a consequence it should be expected that additional states will adopt certification programs.

Certification and licensing are not synonymous terms, although they are often used interchangeably. Webster defines "certify" as "to endorse authoritatively as being of standard quality," while "license" is "formal permission by the authorities to carry on a certain business otherwise illegal." Certification is the first step in a professional-qualification program. Licensing is an adjunct of certification, and the benefits licensing can provide the profession are dependent in a great measure upon the effectiveness of certification programs.

In this discussion major emphasis will be placed on certification because it is the basic part of a qualification recognition program and licensing is actually an adjunctive phase.

Certification programs, which are primarily concerned with the interests of the operator and the public, are usually sponsored by both the operators' professional organization and the state regulatory agency. In the interest of producing the greatest overall benefit, the program is intended to establish and maintain quality operation and professional recognition, high morale, and adequate financial remuneration for water utility personnel. Within this framework, the advantages of a uniform water utility operator certification program will be discussed, as well as the suggestion that the water supply profession, through its representative organizations, formulate and promote such a program.*

* EDITOR'S NOTE: On Apr. 25, 1958, the AWWA Board of Directors accepted a proposal by O. J. Muegge, Director of the Wisconsin Section, establishing a joint committee of AWWA and the Conference of State Sanitary Engineers (CSSE) on certification and training of water works personnel. The scope of the committee is as follows:

Benefits of Certification

The many benefits already provided through existing programs should be reviewed before presenting those expected of a uniform program. In order to be worthwhile, uniformity must provide additional advantages.

There is no precise way to measure the value of certification because there are so many criteria and the relative importance of each is subject to individual opinion. Opinions have been sampled numerous times during the past few years by various groups. Probably the most complete survey was reported on by the Committee on Education of AWWA in 1953 (*1*). The five questions that follow were asked of each of the 23 states that had programs; answers are summarized below each question.

1. Has certification enhanced public health?
Yes: 19 No: 1 Don't know: 3

2. Has it raised quality of operators?
Yes: 18 No: 1 Don't know: 4

3. Has operator morale been improved?
Yes: 16 No: 0 Don't know: 5

4. Has financial status of operators improved?
Yes: 11 No: 3 Don't know: 9

5. Has certification removed jobs from political control?
Yes: 12 No: 4 Don't know: 7

In three of the states polled the certification program was reported to be new and a "don't know" answer was given to each question.

The USPHS polled the state regulatory agencies again in 1957. Among the questions asked were whether certification of operators was or would be of value, and why. Forty states answered affirmatively, three negatively, and three claimed that there were so few treatment plants in their states that certification would be of no advantage in their supervision. The reasons why certification was considered desirable varied, but for the most part they were related to better operation, better operator morale, and better pay for those certified. A point of interest is that each of the three states that had answered "Don't know" to all questions in 1953 answered affirmatively in 1957 and indicated that their certification programs had benefited both operation and operators. Other surveys have shown essentially the same regard for the value of certification.

The 1957 survey showed that there were then 28 states with water operator certification, and that at least two others were actively planning to establish voluntary certification. Eight states had mandatory programs, and several of them are currently striving for statutory certification. The information derived from these surveys indicates that certification—for the most part on a voluntary basis—has raised morale and salaries, improved opera-

1. To collect and summarize information on certification plans and training courses
2. To promote the certification of water utility personnel in all states and prepare material for this purpose
3. To develop a suggested uniform plan for voluntary certification
4. To develop a suggested uniform act for compulsory certification
5. To cooperate with committees and any agencies developing training manuals and augment such manuals as may be desirable to prepare personnel for certification
6. To develop guides for training courses
7. To develop a uniform examination
8. To work for reciprocity between states
9. To collect information on qualifications and salaries of water utility personnel.

tion, removed many jobs from political control, and in general enhanced public health. What improvements or additional benefits, then, are to be derived from adoption of uniform standards of qualification sponsored by the water supply industry and its regulatory agencies?

First, there are some well established points upon which to base a case for recognized uniformity:

1. Because of their growing importance, water supply problems are receiving more attention from public administrators, elected officials, industrialists, civic groups, and conservationists.

2. The mushrooming of suburban areas about urban centers is complicating water system operational problems immensely and will further complicate them if metropolitan growth continues as predicted.

3. There is an increasing demand for larger volumes of high-quality water, and the difficulty of quality production is increasing correspondingly.

4. Salaries, especially in municipal plants in the medium and small towns, are often low, and usually controlled by administrative officials not necessarily experienced nor well informed on water supply or public health.

5. There is a limit to the number of operators who can or will participate in a voluntary certification program. Statutory certification is ultimately desirable to reach this group, which comprises a sizable percentage of the operators in many, if not most, states.

Uniform Certification

Standardization of operator certification is by no means a new proposal. The first positive step toward converting thought into action was taken in 1947 by the Southwest Section of AWWA. From a study of the state certification programs then in operation, a uniform plan was developed and presented to the southwestern states in 1949. These states (Texas, Oklahoma, Arkansas, and Louisiana) adopted similar standards and provided for reciprocity to some degree.

In an allied field the New England Sewage and Industrial Wastes Association has begun a voluntary sewage plant operators certification program for members of the six states represented. The first examinations for qualifications were given in June 1958.

Other states, such as Washington, Idaho, Maryland, Delaware, and the Rocky Mountain states, also regularly cosponsor short-course operator programs regularly, and, because operator training and certification are very closely related, similarity of certification should result eventually.

Uniform Compliance

The first, and probably most basic, consideration in certification is the insuring of uniform compliance with water supply standards. Current USPHS drinking-water standards (*2*)* specify that public water supply facilities are to be operated by "qualified, well trained personnel." There is at this time, however, no uniformly accepted standard for evaluating operator qualifications and training. Although better water utility operation has been accomplished under the various certification programs, a widely recognized, uniform standard for qualification should provide greater stimulus to bring into training and certification programs operators who could not or would not participate formerly, thereby

* Now under revision.

extending the benefits of improved operation. With the united backing of the responsible organizations and agencies of the health and water supply fields, promotion of certification can be carried to public administrators and management as well as to operating personnel. Management, which consists in many instances of elected officials, has a dual responsibility: production of safe, palatable water, and efficient operation of a capital investment that may represent several million dollars of the taxpayers' or stockholders' money. It can be demonstrated that these responsibilties can best be carried out by personnel who are qualified by training and examination in water supply basics and equipment mechanics.

Public Recognition

Professional recognition by government officials and the general public provides the members of a profession with the benefits of prestige and financial gain. An increasing, direct interest in water resources and public water supplies is being taken by both groups. As registration, licensing, and certification are now generally accepted as symbols of competence for other groups with special skills, nationwide water utility operator standards would add status to the improved job stability already provided by state certification programs. If this point is doubted, one need only consider some of the other professions or crafts that have established standards of qualification that are generally recognized by others not in the field.

Model Program

By no means the least of the benefits that a uniform set of standards would produce would be a stimulus to the adoption of a program in those states in which certification has not been established as yet. Proponents of certification in these states would have a strong point in support of their proposals by having at their disposal a uniform code sponsored by the operational and regulatory organizations of the water supply field. It would provide a model program of proved successfulness.

Similarity of Existing Programs

The 1957 study of the USPHS showed surprising similarities in the basic components of the various state programs. Nearly all states have three, four, or five grades for classifying plants and operators. Although there is a greater divergence in plant classification, there is close agreement concerning operator qualifications for corresponding grades. Similarity between neighboring states is usually even more striking. This should be expected, as a state drafting a new certification program would naturally study already successful state programs. These observations suggest two points that support the sponsorship of a uniform program:

1. States planning to begin certification programs—as several are at this time—want a successful model program to work from during the drafting stage. Under a uniform program, problems peculiar to a particular state could be worked into that state's plan, but so long as the basic structure of the model program were adhered to, the purpose and advantages of uniformity would be preserved.

2. Because there is such similarity between state programs already, there would be little disturbance caused to

established programs by their realignment with a uniform set of standards. By normal processes of development, future programs will undoubtedly tend to approach uniformity, as is indicated by the close similarity of provisions of those enacted during recent years. It would take little effort to prepare a model for the use of those states drafting programs and thereby speed up the evolution process.

National Security and Emergencies

The physical facilities of the water systems of 268 cities in 186 designated target areas have been inventoried in detail by the USPHS for the Office of Defense Mobilization. These inventories are stored on tape and machine record cards so that possible bomb damage to any of the systems can be computed electronically for assumed attack patterns, and plans to meet a possible national emergency can be made. This assessment can be made in terms of capacity lost, capacity remaining, and the equipment and materials required for replacement and restoration of capacity. The system also lends itself to hand analysis in case of natural disasters.

No such system exists for operating personnel, however, although a comprehensive system of inventorying personnel would be highly desirable for planning mutual support to maintain the function of vital utilities during emergencies. Nor, as there is no common standard of operator competence, is such a system practical on a widespread scale.

In the event of a critical manpower shortage, vacancies in essential elements of the productive and service forces of the nation will need to be filled quickly with competent personnel. In a service industry as vital as water supply, there can be no room for uncertain or untrained operation. There will neither be time nor manpower to train new operators. A recognized uniform standard of competence would help to recruit and place operators where they are needed most. Without it, the successful maintenance of water supply during emergencies will depend in large part on personal knowledge—a risky substitute for good records and preplanning.

Summary

1. Major benefits are reported to have accrued from individual state certification programs. The primary benefits are improved operation and better morale, status, and pay for those in the water supply profession. This is particularly true where statutory licensing is in effect, and where voluntary programs have been vigorously promoted and publicized.

2. More people outside the water supply profession are realizing the increasingly critical nature of the problems of the industry and are taking an active interest in its development and operation. It is believed that a uniform program, strongly supported by the water supply industry and regulatory agencies, could more firmly establish the benefits already realized and would aid greatly in extending them to members of the water supply profession who have not participated or could not participate before.

3. There is close similarity between the basic provisions of most state certification programs, the agreement being most marked for programs initiated during and since World War II. Provision of a model program for states that are drafting new programs would

speed up this trend and provide a stimulus to certification in those states currently without programs.

4. Uniform provisions could be incorporated into most programs already established without undue upset or realignment of their basic provisions. For those drafting a new program, a successfully tested model would be welcomed.

5. The advantages of uniform certification justify its development and promotion by the cooperative efforts of the water supply organizations and regulatory agencies. Vigorous support and promotion by these groups on a unified basis would be more effective than independent actions, especially in promoting the eventual adoption of statutory qualification requirements.

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Study of Causes and Effects of Underground Corrosion

National Bureau of Standards

A summary of a technical report, prepared July 1958 by the National Bureau of Standards, US Dept. of Commerce, Washington, D.C.

RESEARCHES by the National Bureau of Standards of the US Department of Commerce (NBS) on the corrosion of underground structures, carried on for more than 45 years, have been marked by steadily improved understanding of the causal factors at work and by the development of increasingly effective means of preventing the harmful effects that underground corrosion produces (*1*). An important phase of the work, now essentially complete, has been an extensive field burial program to determine the specific behavior of metals and coating materials when exposed for periods as long as 17 years in a wide range of soil environments. Other phases have led to increased information on the electrical and chemical aspects of the corrosion process, the development of methods and instruments for measuring soil characteristics, improvements in the technique of cathodic protection, and virtual elimination of corrosion due to stray-current electrolysis.

There are now in the United States about 1,000,000 mi of gas, water, and oil pipelines, 170,000 mi of buried power and communication cables, and an unknown number of tanks, pilings, burial vaults, and other wholly or partly buried structures. The annual cost to the pipeline industry alone for protective measures and replacements due directly to corrosion is estimated at $600,000,000. A still greater indirect cost results from loss of products, service shutdowns, and loss of life and property by explosion and fire due to leakage from corroded pipes. Furthermore, as corrosion rates are often unknown engineers waste large quantities of material by specifying unnecessarily large thicknesses in their designs.

Stray-Current and Soil Corrosion

Until about 35 years ago underground corrosion was attributed solely to stray electric currents from external sources such as d-c power lines and electric railways. Such currents pass through parts of underground structures and then discharge to the earth where conditions are favorable; corrosion occurs at the discharge area.

The seriousness of underground corrosion was recognized by Congress in 1910 when the NBS was authorized to investigate the corrosive effects of stray currents and methods for combating them. In 10 years of field and laboratory studies methods were developed that eliminated stray-current electrolysis as a major factor in underground corrosion (*1*). Unexpectedly, however, these studies also showed that serious corrosion often occurred when stray currents were absent.

...In 1922, therefore, a field burial program was initiated to determine the influence of various soil properties on the corrosion of buried metals and to develop further methods for reducing corrosion losses. Data were obtained on nearly 37,000 specimens representing 330 varieties of material. These specimens were exposed, some for periods as long as 17 years, in 95 different types of soil at 128 test sites throughout the United States. The last specimens were removed in 1952 and several more years were required to analyze the data. The major field burial program is now terminated; present work is confined to newly developed materials and the completion of several unfinished studies.

While the field burial program was proceeding electrical and electrochemical aspects of underground corrosion were continuously studied in the laboratory. A differential aeration cell, developed by I. A. Denison and modified by his coworkers, was used to compare the corrosivities of different soils and of different metals in the same type of soil. Studies by W. J. Schwerdtfeger showed that the instantaneous rate of corrosion for ferrous metals in soils could be determined quantitatively from polarization characteristics of the metal.

Byproducts of the investigations include a widely adopted inspection code for pipes and coatings and the development of methods and instruments for measuring the electrical resistivity of soils in the field.

In the course of the field investigations the NBS had the cooperation of: seventeen technical and government organizations; 103 manufacturers, who supplied materials; and of 105 utility companies and municipalities, who provided test sites and labor.

Causes of Corrosion

Most underground corrosion is the result of electrochemical reactions. For such reactions to occur there must be a potential difference between two points of the metal in contact with an electrolyte. It is believed that current flows from the anode area, through the electrolyte to the cathode, and returns through the metal to complete the circuit. The anode area corrodes through loss of metal ions to the electrolyte. Correlation of this theory with actual corrosion of metals underground is complicated, however, because of the many factors which determine not only the amount or rate of corrosion, but also whether corrosion is uniformly distributed over the metal surface or is localized as pitting. The pitting type of corrosion is especially damaging in pipelines and other structures that store or carry fluid, but for load-bearing structures, such as piles, the main concern is with overall loss in weight or strength.

The chief contributing factors in corrosion are the presence of moisture, oxygen, and soluble salts in the soil and the permeability of the soil to these substances. Moisture provides the soil electrolyte, which is composed of hydrogen and hydroxyl ions from the water itself, and also provides a variety of ions from the salts dissolved from the soil. These ions determine the electrical resistivity and the chemical properties of the soil. Oxygen, from the air or from oxidizing compounds in the soil, stimulates corrosion by combining with metal ions. If the resulting corrosion products are removed from the anodic areas, because they are soluble or for other reasons, corrosion proceeds; if they accumulate they may protect the metal against fur-

ther corrosion or, if they are more cathodic than the bare metal, they will accelerate and localize the corrosion.

Other factors which determine the amount of current that flows from metal to soil are the size, number, and location of anodic areas. Galvanic corrosion may result because of contact between dissimilar metals or because of local differences in the packing of the soil, which may produce oxygen-concentration cells; the regions with less oxygen are anodic with respect to those with more.

Bacteria must also be considered, particularly the anaerobic, sulfate-reducing bacteria that convert soluble sulfates to sulfides. These are most active in poorly aerated swamp areas where the pH of the soil water is about neutral and there is enough organic matter and soluble sulfates for the organisms to thrive.

Results of Program

The 95 soil types used in the field burial program had wide differences in physical and chemical properties. In texture the soils varied from soft, spongy peats through soft clays, loams, and silts, to coarse-grained sands and gravels. Resistivities ranged from 51 ohm/cm, approximately the same as sea water, to resistivities more than 1,000 times larger, which indicated the absence of soluble salts. Chemically the soils ranged from extreme acidity (a pH value of 2.6) to high alkalinity (a pH value of 10.2), and from highly oxidizing to definitely reducing. In addition, there were striking differences in the kinds and amounts of soluble salts present.

In the first extensive burials, in 1922, specimens of commonly used ferrous pipe materials were buried at 47 test sites. In 1928 similar ferrous materials and some copper and copper alloys were buried in a new group of sites and a burial program was started on materials with bituminous coatings. Between 1932 and 1941 additional burials were made of low- and high-alloy irons and steels, copper and copper alloys, zinc, lead alloys, lead-coated steels, galvanized iron, tin-coated copper, various nonbituminous organic coatings, and asbestos-cement pipe.

Ten or twelve specimens of each material were usually buried at each site and two specimens were removed periodically so that corrosion data were obtained for maximum exposures of 12–17 years for all materials. Specimens were usually placed in a single row in a long, narrow trench and were arranged so that two samples of each material could be removed without disturbing the specimens still in the ground. Exhumed specimens were treated in the NBS corrosion laboratory by chemical and mechanical procedures to remove the corrosion products without significant loss in weight or mechanical injury to the uncorroded metal. Measurements of weight loss and pitting depth were then made.

Plain Ferrous Metals

The plain, ferrous pipe materials represented in the field tests were open-hearth iron and steel, hand-puddled and mechanically puddled wrought iron, Bessemer steel, plain carbon steel, and pit-cast and centrifugally cast iron.

The field test results for these metals, as well as those for low-alloy steels, exhibit very clearly the controlling influence of the soil on the character of the corrosion. All of the plain ferrous materials showed similar

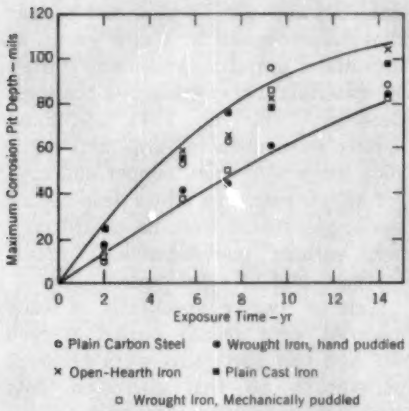

Fig. 1. Corrosion of Ferrous Pipe

This graph illustrates some of the data obtained on the maximum depth of corrosion pits in five types of ferrous pipe, as indicated, buried in clay. Curves represent the extremes. Individual curves for each metal would be within these extremes. These curves indicate that no one material was superior to the others, and that all of these materials corrode at about the same rate in the same soil.

corrosion patterns when buried in the same soil (Fig. 1) but the type of corrosion varied widely in different soils (Fig. 2). In general, a high initial corrosion rate which decreases after a few years to almost complete cessation is found in well-drained soils with high resistivities; the corrosion rate is nearly constant after the first year or two in poorly drained soils with low resistivities (Fig. 3).

Alloy Steels and Irons

Data were obtained by the NBS on the following low-alloy steels: copper-bearing steel, copper-molybdenum open-hearth iron, nickel-copper steels, and steels containing from 1 to 6 per cent chromium with and without molybdenum.

The general effect of the alloying elements was to lower the initial rate of weight loss but increase the initial rate of pitting, as compared with plain carbon steel. Except in very poorly

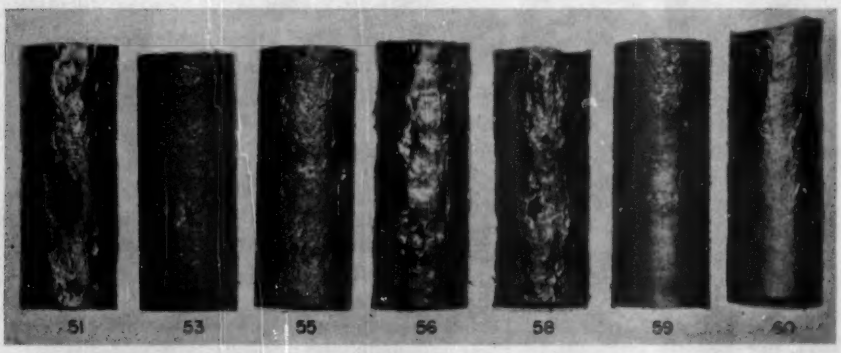

Fig. 2. Effect of Different Soils on Type of Corrosion—Carbon Steels

Photographs illustrate the contrasting corrosion patterns produced by different soil environments on carbon steel specimens which were buried for approximately 14 years. The numbers under the specimens refer to the soil environment in which they were placed during the NBS test; 51, Acadia clay at Spindletop, Tex.; 53, Cecil clay loam at Atlanta, Ga.; 55, Hagerstown loam at Loch Raven, Md.; 56, Lake Charles clay at El Vista, Tex.; 58, muck at New Orleans, La.; 59, Carlisle muck at Kalamazoo, Mich.; 60, Rifle peat at Plymouth, Ohio.

aerated and reducing soils, however, the pitting rate diminished more rapidly for the alloy steels than for plain steels. Chromium and molybdenum were particularly effective in reducing the corrosion of low-alloy steels in the most corrosive site, a cinder fill.

The higher-alloy steels tested contained a maximum of 18 per cent chromium, with and without nickel and molybdenum. Increasing the chromium content caused a gradual decrease in weight loss but pitting was accelerated by additions of chromium beyond 6 per cent. The tendency of high concentrations of chromium to accelerate pitting appears to be neutralized by adding sufficient nickel to produce steels of the austenitic type (Fig. 4).

Field tests on low-alloy cast irons, containing up to 3 per cent nickel with and without copper, showed that the presence of such amounts of nickel or copper had no significant effect in any of the soil environments. Austenitic cast iron was considerably more resistant to corrosion than plain cast iron.

Copper, Brass, and Lead

Results on copper and copper alloys indicate that tough-pitch copper, deoxidized copper, copper containing up to 3 per cent silicon with and without tin, and red brass (15 per cent Zn) all behave essentially alike. Soils, including cinders, with high concentrations of sulfides, chlorides, or hydrogen ions were the most corrosive toward these materials.

The corrosion rate of Cu–Zn alloys with more than 27 per cent zinc increased approximately in proportion to the amount of zinc and was generally accompanied by dezincification, except in soils with moderate or high concentrations of sulfide. In the high-sulfide soils the corrosion rate decreased as zinc content increased and dezincification did not occur.

Chemical, antimonial, and tellurium lead showed no appreciable difference in corrosion behavior. The corrosion rate of each tended to increase as aeration of the soil decreased. Organic acidity was corrosive, but in soils high in sulfates, chlorides, or carbonates

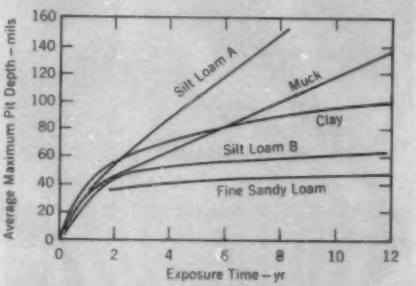

Fig. 3. Effect of Different Soils on Rate of Corrosion

Curves represent the average corrosion rates of plain, carbon steel in five different soils. They indicate that in well-drained soils with high electrical resistivities (the fine, sandy loam and silt loam B, *for example) corrosion rate may be high initially but decreases after a few years. In poorly drained soils with low resistivities (the muck and silt loam* A, *for example) corrosion rate is nearly constant after the first year or two. Similar results were obtained with other plain, ferrous metals.*

the corrosion products formed a protective coating.

Comparison

To compare the corrosion resistances of plain iron and steels, copper, lead, and zinc, the soils were divided into four groups: well aerated, poorly aerated, alkaline, and high in sulfide or sulfate. When corrosion-time curves were plotted (Fig. 5) for specimens buried in representative soils of these

types it was found that plain iron or steel corroded much more rapidly than the other metals in all the soils except the one high in sulfate. In high-sulfate soil zinc corroded more than steel. Only lead could be expected to withstand for long the corrosive action of a soil with a high sulfate concentration.

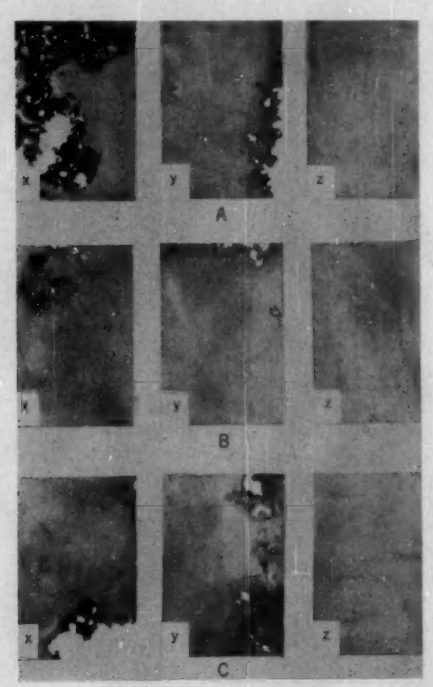

Fig. 4. Effect of Different Soils on Type of Corrosion—High-Alloy Steels

These specimens illustrate the contrasting corrosion patterns produced by different soil environments. All three specimens were buried for 14 years. Specimen X was 12 per cent chromium steel; specimen Y was 18 per cent chromium steel; Specimen Z was 18 per cent chromium, 9 per cent nickel steel. The letters under the specimens refer to the soil environment in which they were placed: A, *clay;* B, *silt loam;* C, *fine, gravelly loam.*

In the well-aerated and poorly aerated soils which are representative of most of the United States copper showed the highest corrosion resistance. This superiority is especially marked in the poorly aerated environment where the corrosion rates of iron or steel, zinc, and lead are proportional to time. In the well-aerated environment, the rates of corrosion of these metals decreased rapidly with longer periods of exposure.

Corrosion Prevention

Coatings

Field tests on galvanized coatings over iron and steel showed that a 2-oz/sq ft coating of zinc was sufficient protection in inorganic oxidizing soils. A coating of 3-oz/sq ft was needed in inorganic reducing soils and still heavier coatings in high-reducing organic soils. For steel coated with lead and copper coated with tin, both by the hot-dip process, it was found that in a great many soils the local corrosion penetration is much deeper than the thickness of generally available commercial coatings.

Coatings of vitreous or porcelain enamel revealed no signs of deterioration after 14 years of exposure. Baked phenolic coatings showed marked superiority to air-dried phenolic coatings in preventing pit formation in the underlying steel. Rubber and rubberlike coatings were also very successful, mainly because of their great thickness. Numerous other organic coatings failed to give adequate protection because of insufficient thickness or unsatisfactory bonding between the metal and the coating.

Extensive field tests were made on all bituminous coating materials com-

mercially available at that time (1929–32), including shields, wrappings, and reinforcing materials. As a result of these experiments, performed with the cooperation of the American Gas Association and the American Petroleum Institute improved methods of applying the coatings were developed, many previously used coatings were removed from the market, and new specifications for bituminous coatings were adopted.

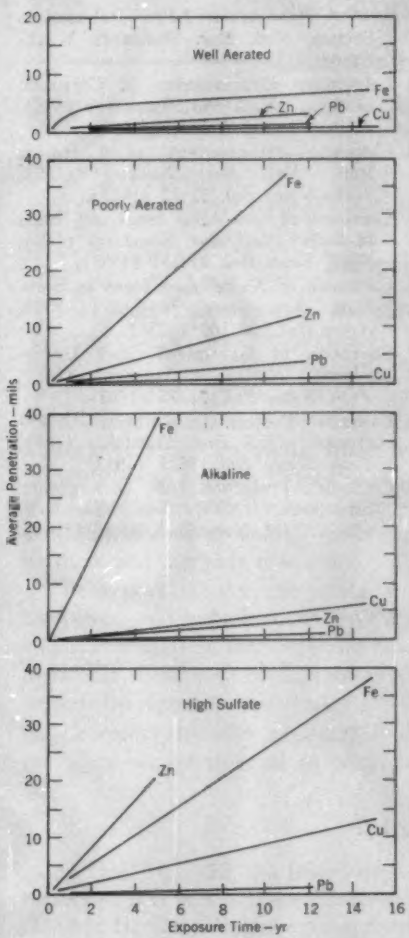

Fig. 5. Effect of Different Soils on Rate of Corrosion Penetration

These graphs compare the rate of corrosion penetration on plain iron (Fe), copper (Cu), lead (Pb), and Zinc (Zn) in four different types of soil environment.

Asbestos-Cement Pipe

Pipes of asbestos-cement, now widely used for transporting water, were exposed for periods of as much as 13 years. In general, the data show an increase in strength during the first few years due to the curing process that cement products normally undergo in moist atmospheres. However, after completion of this curing period there was a loss in strength, a decrease in apparent specific gravity, increased water absorption, and some softening of the surface. These effects were accelerated by both organic and inorganic acidity in the soils.

Cathodic Protection

Since the early 1930's the method of cathodic protection has come into more and more extensive use as an alternative or supplement to protective coatings. The method consists of impressing electromotive forces on the underground structure so that the entire structure remains cathodic to the soil at all times. This prevents positive metal ions from passing into solution and thus blocks the corrosion reaction.

If electric power is available it is converted to d-c, if not already in that form, and auxiliary anodes of scrap iron, graphite, or other materials are used to carry the current into the earth. Where power is not easily available, aluminum, magnesium, or zinc are used as sacrificial anodes to supply the

needed electromotive force by galvanic action.

Experimental and theoretical investigations by the corrosion laboratory have contributed to cathodic protection technique since its early development. For example, studies were made which helped determine which soil conditions are favorable for the use of zinc sacrificial anodes.

Publications

A list of publications on underground corrosion, cathodic protection, and stray-current electrolysis, including selected articles in outside journals, can be obtained from the NBS (*2*). The bibliography in the Romanoff circular (*1*) contains a more complete list of NBS articles in outside journals and includes references to the work of other laboratories. Descriptive summaries of various phases of underground corrosion research at the NBS are also available (*3–9*).

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Use of Backflow Preventers for Cross-Connection Control

Joint Committee Report

A report of Joint Committee 8210 J—Backflow Preventers, submitted by Andrew T. Dempster (Chairman), Director, Bureau of San. Eng., Dept. of Health, Detroit, Mich. Other AWWA representatives were R. L. Derby and R. H. Ellis; Conference of State Sanitary Engineers representatives were W. N. Gahr, P. J. Houser, and E. C. Meredith.

Editorial Preface

THE Joint Committee on Backflow Preventers was established in April 1953 at the direction of the Board of Directors of AWWA and the Conference of State Sanitary Engineers (CSSE) to study backflow-preventing equipment. Later the scope of the committee activity was expanded to include the whole field of cross connections and methods of control.

The report of the committee was completed and submitted to AWWA and CSSE in 1957 for study and comment. In 1958 both organizations accepted the report for publication.

The report provides an assembly of the pertinent information on backflow preventers and states certain findings concerning the use of this type of equipment. Its significant contribution is that it emphasizes the need for continued study and investigation and specifically designates seven areas for exploration by a future committee.

The report is printed in order to stimulate renewed interest in the subject and to solicit comment. It does not represent a final policy statement on behalf of AWWA or CSSE with regard to cross connections or backflow preventers.

The committee members worked long and diligently on their assignment. They produced a progress report worthy of study.

Introduction

On Dec. 31, 1952, the Board of Directors of AWWA and the Conference of State Sanitary Engineers requested that a joint committee be created to undertake a comprehensive study and to issue a specific report on certain backflow preventers. The committee was to be composed of three members from AWWA and three members chosen from CSSE. The membership was finally established on Apr. 15, 1953, and preliminary work started shortly thereafter.

Previous committees of AWWA and other organizations assigned to the study of the cross-connection problem had generally agreed that no new cross connection between safe and unsafe water supplies should be allowed. It is self-evident that completely sepa-

rate systems of piping for potable and nonpotable water will offer the greatest factor of safety, provided they remain continuously separated. Difficulties have arisen, however, in maintaining complete separation between such systems where both are present within a property. A possible solution to this difficult problem is offered by the development of a backflow-preventing device which provides for a reduced-pressure zone between two check valves. The newer backflow-preventing devices have made the reexamination of the cross-connection problem desirable.

The committee's instructions limited the scope of the committee to a study of "a group of special devices (for example, a reduced-pressure zone between two check valves) designed and used for the protection of the public water supply from contamination where two or more supplies (safe and unsafe) are used interchangeably for various purposes." More specific instructions covering this particular device were issued to the joint committee in the following assignments:

1. To investigate and report on the essential parts of a dependable unit
2. To investigate and report on friction loss through equipment at various rates of flow
3. To investigate and report on the possibility of impairment of service and safety through clogging or breakdown
4. To investigate the frequency requirements for inspection and the maintenance requirements of such units after installation
5. To determine and recommend where such equipment is applicable
6. To report on proper characteristics of installation, such as location, accessibility, and housing.

In addition to the above, it was suggested that the committee review previous reports issued by former AWWA committees on cross-connection control, the last of which was published in 1942 (*1*), and to use these reports as a point of departure for its study.

It is recognized that much advancement has taken place in the field of cross-connection control during the last 10–15 years. Intensive research and development during this period had resulted in the development of a completely new principle of operation for mechanical backflow prevention devices—the reduced-pressure principle. Hundreds of these devices have been in actual field use in Southern California for more than 15 years and, as a result, there has been produced sufficient factual material with which to evaluate them. The conclusion was reached that if this type of equipment were producing the results claimed for it by the manufacturers and by those water purveyors and health authorities who have had experience with it, the advantages and disadvantages (if any) of using this type of equipment should be covered in a full, up-to-date committee report. Equipment of this kind might fill a definite need for a safe mechanical backflow prevention device to be used instead of air gap separation in cross-connection control.

Definitions

The definitions that follow are for the purpose of establishing the meanings of certain words and terms as they apply to this report.

Approved shall mean approved by or acceptable to the water purveyor, the health authority, or any other agency having jurisdiction. Where ap-

plicable to private fire service, *approved* shall, in addition, mean approved by the Factory Mutual Engineering Division or Underwriters' Laboratories, Inc.

Backflow shall mean the flow of water or other liquids into the distribution pipes of a potable supply of water from any source or sources other than its intended source (see back siphonage).

Back siphonage is the flowing back of used, contaminated, or polluted water from a plumbing fixture or vessel into a water supply pipe due to a negative pressure in such pipe (see backflow).

Public potable-water supply system shall mean all pipes, conduits, tanks, receptacles, fixtures, equipment, and appurtenances used to produce, convey, treat, or store potable water for public consumption or use.

Consumer's potable-water piping system shall mean all pipes, conduits, tanks, receptacles, fixtures, equipment, and appurtenances used to produce, convey, store, or use potable water under the control or operation of the private consumer.

Nonpotable water shall mean water which, without treatment, would be unsafe for human consumption.

A *cross connection* shall mean any connection between a public potable-water supply system or a private consumer's potable-water piping system and any other source or system, whereby it is possible to introduce into any part of the potable-water system any water or substance other than the intended potable water from which the system is primarily supplied.

The *point of cross connection* shall mean the specific point or location in a public potable-water supply system or in a consumer's potable-water piping system where a cross connection exists.

An *industrial piping system* shall mean all pipes, conduits, tanks, receptacles, fixtures, equipment, and appurtenances used to produce, convey, store, or use nonpotable water or water not certified for human consumption, including water from an approved water supply which has entered or is being used in any part of the industrial piping system. This industrialized system is used to isolate the potable-water supply from areas in plants or facilities in which potential hazards to the safety of the supply exist.

An *approved water supply* shall mean a water supply that has been approved or accepted for human consumption by a state health department or other authority having jurisdiction.

An *unapproved water supply* shall mean a water supply which has not been approved or accepted for human consumption by the health or water authorities having jurisdiction.

A *health hazard* shall be considered to exist when an unprotected cross connection is established between any part of a public potable-water supply system or a consumer's potable-water piping system and any nonpotable or unapproved source or system, whereby contaminated substances could enter the potable system so as to create an immediate or potential hazard to the health of the persons using the waer.

A *system hazard* shall be considered to exist when an unprotected cross connection is established between any part of a public potable-water supply system or a private consumer's water piping system and any other source or system, whereby substances could enter those systems which would not

be considered hazardous to health, but which could create a nuisance, cause impairment of water quality, or cause physical damage to the system or its appurtenances.

The *degree of hazard* shall mean the degree, nature, and possibility of pollution encountered at the point of cross connection as determined or established by the water purveyor, the health agency, or other authority having jurisdiction.

A *backflow prevention device* is specifically designed and approved to prevent the backflow and back siphonage of contaminated or polluted water or other liquid into the potable-water system.

A *reduced-pressure principle backflow prevention device* shall mean a device containing within its structure a minimum of two check valves, together with an automatically operating pressure differential relief valve located between the two check valves. The first check valve reduces the supply pressure by a predetermined amount, so that, during normal flow and at cessation of normal flow, the pressure between the checks shall be less than the supply pressure. In case of leakage of either check valve, the differential relief valve, by discharging to atmosphere, shall operate to maintain the pressure between the checks less than the supply pressure. The unit shall include tightly closing shutoff valves located at each end of the device, and each device shall be fitted with properly located test cocks.

An *air gap separation* shall mean a physical separation or air gap between the free-flowing discharge end of a potable-water supply line and an open, or nonpressure, receiving vessel. Requirements for air gap separation shall conform to the standards in ASA 40.4–1942. (The air gap shall be at least twice the diameter of the effective opening of the supply pipe measured vertically above the top rim of the vessel, but in no case shall it be less than the minimum set forth in the ASA standards.)

An *acceptable or approved backflow prevention check valve* shall be drip-tight and constructed to assume rapid and positive closure under all conditions of service. It shall permit no leakage in a direction reverse to normal flow, and when seated shall permit no leakage in the intended direction of flow when the inlet pressure is a predetermined minimum above the outlet pressure.

An *acceptable or approved double check valve assembly* shall mean a device incorporating, as an operating unit, a minimum of two check valves acceptable for backflow prevention, generally separated by an appropriate spacer. The assembly shall include two tightly closing shutoff valves located at each end of the unit and shall be equipped with properly located test cocks for testing the tightness of each valve.

Special, fire service, all-bronze swing check valves shall mean an assembly of two, all-bronze, swing check valves conforming to the specifications of, and approved by, the Factory Mutual Engineering Division or Underwriters' Laboratories, Inc. Valves of this type are installed in series and generally separated by a 3–5-ft spacer. Shutoff valves are included at the inlet and discharge sides of the assembly, together with drains and necessary test connnections.

Recognized Methods

In keeping with the purpose of this work, it is considered necessary to review briefly the recognized backflow

prevention devices, methods, and systems that have been most frequently used in cross-connection control. This may prove helpful in comparing the older devices and methods with the newer reduced-pressure principle backflow prevention devices, which are the primary subject of this report. It should be emphasized that all devices or methods need periodic inspection and maintenance to insure their effectiveness.

Double Gate Valves With Valved Bleeder

Sometimes a combination of two gate valves with a valved bleeder located between them has been used to protect a cross connection between a potable- and a nonpotable-water supply. The purpose of the bleeder is to indicate any leakage through either of the normally closed gate valves.

Comment. When the two gate valves are open and the bleeder valve is closed, an unprotected cross connection exists between the two systems. This condition, as well as the tendency to allow the bleeder to remain closed, precludes acceptance of this method.

Single Check Valve

The single check valve was probably the first automatically operating device used on cross-connection control to prevent backflow and back siphonage into potable-water lines.

Comment. This device is inadequate for backflow protection.

Double Check Valve Assembly (Commercial Type)

The commercial double check valve assembly is composed of two single check valves, usually with a spacer between. This device has been used quite extensively in cross-connection control work, particularly where more protection was required than could be secured from the single check.

Comment. The commercial double check valve has a limited application, depending upon the degree of hazard. This device contains no provision for visual or mechanical indication of malfunction or failure.

Double Check Valve Assembly (Internally Weighted Type)

The internally weighted assembly is composed of two single, internally weighted check valves, usually with a spacer between. This is an improved type of check valve with a rubber-faced disk and a metal-faced seat. The disk is internally weighted to give a positive closing moment.

Comment. This device has been used in recent years, as it is considered more reliable than the usual commercial type of check valve. This assembly also contains no provision for visual or mechanical indication of failure.

Special, Fire Service, All-Bronze Double Check Valves

Special, all-bronze devices have been used extensively on fire service connections and, to a limited extent, where protection has been required against special hazards.

Comment. Records of periodic tests indicate performance to have been satisfactory. These devices provide no automatic, visual, or mechanical means of indicating backflow.

Air Gap Separation System

The air gap system has enjoyed widespread recognition and is used as a means of protecting hazardous cross connections.

Comment. The separation of a potable-water system and a nonpotable system by an adequate fixed air gap and tank will always be an acceptable method of preventing backflow. Vigilance is always necessary to prevent the bypassing of this type of protection, however, as it is in all other types of protection.

Barometric Loop

This is composed of a loop of pipe rising to an elevation at its topmost point of approximately 35 ft above the highest outlet it supplies.

Comment. The loop is effective against vacuums occurring on the upstream side only. It has no value where back pressures can occur. These limitations restrict its general use.

Separate Systems

Separate systems are ideal, provided no cross connections are made between a potable-water system and a nonpotable source, system, or supply.

Comment. The expense factor may be high.

Swivel Device

The swivel provides a means of supplying equipment through a swinging pipe section or a four-way plug valve from a potable or a nonpotable source, but never simultaneously from both sources.

Comment. This offers a definite protective advantage over a direct connection, but does not prevent backflow subsequent to the time a changeover is made from a contaminated source to a potable source. It should always be used in combination with an acceptable backflow prevention device.

Vacuum Breakers

A *nonpressure* vacuum breaker is used extensively on plumbing fixtures and related equipment to prevent back siphonage when subatmospheric pressures occur in the supply line.

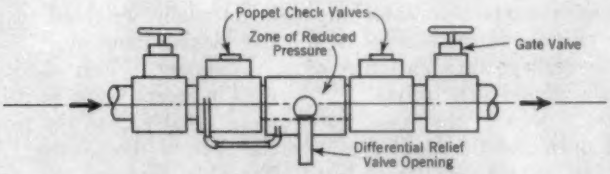

Fig. 1. Reduced-Pressure Backflow Preventer

The poppet check valves are spring loaded to close; the diaphragm-operated relief valve is spring loaded to open, but normally held closed by the inlet pressure.

Comment. It must be located on the discharge side of the last control valve and, to prevent sticking, must not be kept under constant line pressure for long periods of time. It has no value where the line is subject to back pressure. Elevation is determined by tests for each model.

The *pressure* vacuum breaker is used on a supply line to prevent back siphonage where it is undesirable to use a nonpressure type at each outlet. It may be located on the supply side of the last control valve.

Comment. In order to prevent sticking, it must be located at a suffi-

cient elevation above the highest outlet to insure that it will open if a subatmospheric pressure occurs in the supply line. The vacuum breaker has no value where lines are subject to back pressure. It should always be used in combination with one or two approved backflow prevention check valves, as recommended by a local or state authority.

Reduced-Pressure Backflow Preventer

This report is primarily concerned with reduced-pressure backflow prevention devices. Figure 1 illustrates the component parts of such a device

Description

In order to evaluate properly the reduced-pressure backflow prevention device in comparison with other backflow prevention devices and methods, it is essential to understand its mechanical and hydraulic operation. Of primary importance is the function and operation of the first poppet check valve, known as the reducing check, and its relation to the pressure differential relief valve.

The first check is mechanically or hydraulically loaded to a closed position by a predetermined amount of pressure. During normal operation and flow, the inlet pressure of the water when passing this check (regardless of what that pressure may be) is automatically reduced by this predetermined amount. This results in setting up between the two checks a zone of reduced pressure that is always *below* the pressure on the inlet side of the first check.

The zone of reduced pressure is maintained lower than the inlet pressure by the operation of a differential relief valve which automatically opens to drain the zone to less-than-inlet pressure by the predetermined amount, if the inlet pressure is lowered or if superior back pressure at the outlet occurs with the downstream check leaking.

The second check is lightly loaded to a closed position and provides the zone in which reduced pressure is maintained. In addition, it prevents unnecessary drainage of the system under backflow conditions.

Assignment 1—Essential Parts

In 1945, the University of Southern California (USC) built and completely equipped a laboratory for the exclusive purpose of conducting research in the use and reliability of backflow prevention devices and in the general field of cross connections. This nonprofit organization is known as the University of Southern California Research Foundation for Cross-Connection Control.

Particular emphasis was placed on investigating, both in the laboratory and in the field, a group of backflow prevention devices operating on the reduced-pressure principle. Many hundreds of these units have been installed and are in use in the Los Angeles area. Access to these devices and to operational information was made available to the foundation research personnel. They were able to make extensive checks and tests of the equipment under laboratory and actual field operating conditions. This situation as it applied to reduced-pressure backflow preventers was unique in that it prevailed, at that time, in no other area in the country.

The result of this investigation, much of which was made in cooperation with health, plumbing, and water officials, was the issuance by the foundation in 1948 of a report (*2*) by Robert E. Vivian, director, Kenneth C. Reynolds, supervisor, and their staff The report included design, operation, and materials specifications covering a dependable reduced-pressure backflow prevention device. Because of its excellent background, a portion of the report is considered to cover adequately the request contained in Assignment 1 and, with the permission of the foundation, is reprinted in part, as follows:

TABLE 1

Suggested Size of Minimum Area of Pressure Differential Relief Valve Openings and Required Rates of Discharge

Device Size *in.*	Minimum Discharge *gpm*	Minimum Area Through Passageways of Relief Valve Openings
1 and under	5	¾ in. IPS area*
1¼ and 1½	10	¾ in. IPS area
2	20	1 in. IPS area
2½	20	1 in. IPS area
3	30	1¼ in. IPS area
4	40	1½ in. IPS area
6	40	1½ in. IPS area
8	60	2 in. IPS area
10	60	2 in. IPS area
12	60	2 in. IPS area
16	60	2 in. IPS area

* Iron pipe size area.

The staff of the foundation has . . . come to the conclusion that the [reduced-pressure] backflow preventer [described below] actually furnishes as much protection as the air gap method and may be used in place of it, provided an adequate testing and maintenance program is instituted.

The [reduced-pressure] device is recommended for use on cross connections where health hazards exist.

A. Operation

1. A [reduced-pressure] device shall include two or more checks. An automatically operating differential relief valve shall be located between [the] two checks. During normal flow and at cessation of . . . flow, the pressure in the zone between these two checks shall be less than the supply pressure.

2. At a . . . flow of from 0.5 fps into the inlet of the device to cessation of . . . flow, the device shall operate to maintain the pressure in the zone at least 2 psi less than the pressure in the supply lines.

3. When the pressure at the inlet to the device drops to 2 psi, the pressure within the zone shall be atmospheric. When the pressure at the inlet drops below 2 psi, the relief valve shall open further and shall be fully open when the inlet pressure reaches atmospheric or goes below atmospheric.

4. When the inlet pressure is 2 psi or more, the relief valve shall discharge from the zone to atmosphere the . . . quantities of backflowing water [shown in Table 1], and the pressure in the zone shall be at least ½ psi below the inlet pressure.

5. When the inlet pressure is less than 2 psi, the pressure differential relief valve shall discharge water from the zone to atmosphere with the rate of discharge corresponding to the data shown [in Table 1], and the pressure in the zone shall not exceed 1½ psi.

B. Material

1. All moving parts and trim shall be made of corrosion-resisting material.

2. All springs shall be made of stainless steel or equal.

3. The rest of the unit shall be made of . . . a corrosion-resisting material or shall be coated with a satisfactory corrosion-resistant material.

4. A complete backflow prevention unit shall have a control valve at each end.

5. Test cocks.

a. All units shall be equipped with test cocks (brass or equivalent plug cocks), located as follows:

(1) On the inlet side of first control gate

(2) Between control gate and first check valve

(3) Between check valves

(4) Between last check valve and second control gate.

b. Size of test cocks (brass or equivalent plug cocks, female pipe thread):

(1) Devices 1 in. and under—[test cock] $\frac{1}{8}$ in. (iron pipe size) minimum

(2) Devices over 1 in. and including 2 in.—$\frac{1}{4}$ in. (iron pipe size) minimum

(3) Devices over 2 in. and including 4 in.—$\frac{1}{2}$ in. (iron pipe size) minimum

(4) Devices over 4 in.—$\frac{3}{4}$ in. (iron pipe size) minimum.

C. Clearance

Clearance shall be such that the device shall function satisfactorily for a minimum of 3 years under average water conditions and without maintenance and repair.

D. Effect of Pressure Fluctuation

The relief valve shall not "spit" excessively under ordinary fluctuations of line pressure.

E. Failure of Control System

The failure of any part of the control system shall not constitute a bypass around one or more check valves unless there is visible indication of that failure.

F. Valve Markings

Each device shall have the following markings on each side:

1. Manufacturer's name or trademark
2. Model number
3. Individual serial number
4. Size
5. Direction of flow.

G. Laboratory Tests

1. Each size and model must undergo laboratory tests for operating characteristics.

2. A full set of working drawings shall be furnished with each size and model of device to be tested.

3. The laboratory shall be notified of any change in design, material, or operation of an approved device which is in the field or which is offered for sale. The laboratory, at its own discretion, may or may not require another test. Failure to notify the laboratory of any changes may result in withdrawal of approval of the size and model concerned.

4. Devices will be tested and inspected for the following:

a. Flow loss *

b. Conformance to operating specifications

c. Materials

d. Conformance to working drawings (Any special assembly tools must be furnished.)

e. Conformance to other requirements which may be deemed necessary.

H. Field Tests

1. Only devices passing laboratory tests may be submitted for field tests.

2. Three devices of one size shall be submitted for field tests. In each case, the laboratory will determine what size or sizes will be required for field tests. A minimum of 6 months will be required for this test before a provisional approval will be given. Three additional units will then be required for other field tests.

Assignment 2—Friction Losses

The head loss through a reduced-pressure backflow prevention device is not excessive when consideration is given to the protection afforded. In use of this device as an alternate to air gap separation, having up to 100 per cent loss of head, it can be observed that the loss of head is considerably lower. Aside from this built-in head loss feature, from which the device derives its name, it has much the same head loss and flow characteristics as other devices of a similar design.

* "Flow loss" refers to pressure loss.

The proper performance of a reduced-pressure backflow preventer requires that the first check valve reduce the pressure of the water as it flows from the supply line into the device. This preestablished drop varies in different devices and in different sizes from approximately 7 to 11 lb. The purpose of this reduction is twofold: [1] it establishes in the device a permanent zone in which the pressure is maintained lower than the inlet pressure; and [2] as long as this reduced pressure balance exists in the zone, the differential relief valve remains closed. When this balance is upset in such a way as to cause this reduced-pressure zone to approach the higher inlet pressure, the relief valve acts to maintain the proper balance differential by discharging the excess pressure to atmosphere. An analysis of this mechanical operation indicates it to be based on the fact that water cannot flow from a region of low pressure to a region of higher pressure.

Table 2 shows sizes, flows, and the range of head losses of reduced-pressure backflow devices currently available as obtained from test data from the laboratory of the USC Research Foundation for Cross-Connection Control.

The friction loss characteristics are such that adequate pressure must be provided at the desired rate of flow to overcome these losses and provide the desired pressure required for use. In areas where low pressure ranges are encountered, it is advisable to check carefully on both the built-in and the rated-flow head loss factors before making installations, unless booster pumps are already, or will be, provided.

The joint committee has been interested in the possibilities of reducing head loss through a reduced-pressure backflow prevention device during its

TABLE 2

Sizes, Flow, and Head Losses

Size of Device *in.*	Rated Flow* *gpm*	Head Loss—*psi*			
		No Flow†	At One-Third Rated Flow‡	At One-Half Rated Flow‡	Full Rated Flow‡
¾	34	7	11	15	33
1	53	8	15–17	16–19	24–32
1¼	75	8	15	16	26
1½	100	7–8	18	18–21	20–34
2	160	7–8	13–17	13–17	14–24
2½	225	8–9	14–15	15	19–20
3	320	7–9	10–16	11–17	12–20
4	500	8–10	12–16	13–17	13–21
6	1,000	7–9	12–16	13–16	18–19
8	1,600	8–10	13	13.5	14–17
10	2,300	10–11	13	13–14	14–21

* The designated safe rate of flow for these devices has been partially based on the safe maximum operating capacity requirement standards for displacement or compounded meters adopted by AWWA and NEWWA in sizes ¾–12 in. inclusive. The flow requirements for 1½-in. and 2½-in. meters have been obtained by interpolation.

† Design opening-moment pressure (built in), extracted from head loss curves compiled by the USC research foundation. Valves will vary slightly with different manufacturers' products.

‡ Average or normal flow is approximately one-third to one-half of the maximum safe rated flow. Head losses at full rated flow obtained in some cases by extrapolation. Head loss ranges indicate variations between different types of devices in the same size, rather than variation in observations for the same device.

study of such devices. Although the cost of the devices has not been a subject for the study of the committee, it is a factor in their selection as protective devices in establishments where there is an actual or potential cross connection. The manufacturer of one of these reduced-pressure backflow preventers has recently informed the committee of the possibility of reducing both the head loss and the cost of the devices for the majority of installations by making backflow preventers for three different pressure ranges. This would decrease the pressure drop in the devices designed for the lower pressure ranges and thereby provide higher available pressures on the discharge side of the backflow preventer. It is also proposed to reduce the size of the relief valve openings, as it is thought that the present design is more than adequate to relieve the amount of water that could possibly leak through even a poorly maintained downstream check valve in the device. The devices built for the lower pressure ranges and all the devices that could use smaller relief valve openings could then be reduced in cost over the presently designed backflow preventers.

The Department of Water and Power of the city of Los Angeles has requested the USC research foundation to investigate and evaluate the feasibility of these two changes in the design of this type of device, as the reduction in size of the relief valve would be a deviation from the specifications promulgated by the research foundation.

Assignment 3—Clogging and Breakdown

Clogging or breakdown of any reduced-pressure backflow prevention device is always a possibility. There is little probability that any clogging that would impair the service is likely to occur. Many thousands of field test reports, covering the operation of reduced-pressure backflow prevention devices, have been made available to the committee for review. These reports were made by inspectors from municipal departments of health, water, and plumbing, private testing agencies, manufacturers' representatives, and field inspection crews from the USC foundation. A study of these reports discloses very few cases where foreign objects have been found. None of these has stopped flow in the normal direction or caused the device to become inoperative as a backflow preventer. There has been a complete absence of clogging or failure in those devices constructed in conformity with the specifications established by the USC research foundation.

Breakdown in a reduced-pressure backflow preventer implies the existence of a complete mechanical failure of all reverse-flow barriers and the differential relief valve, thus making it possible for backflow to occur through the device.

There have been no reports that this has ever occurred in devices currently approved by the foundation. Should the two check valves fail, the differential between the pressure in the central zone and the inlet pressure will tend to equalize, the relief valve will open, and water in amounts equal to the leakage through the two check valves will be discharged to atmosphere. Should the compression spring or diaphragm in the differential relief valve fail, the device will still operate to prevent backflow. The other possibilities of failure of the device will result from corrosion, which would seal off the equalizing lines or the

ports to the relief valve, or by the capping of the discharge opening therefrom, which could prevent the relief valve from opening or discharging. This in itself would not cause the device to fail, except when it happened simultaneously with both checks leaking. Under this circumstance, with no discharge from the relief valve, there would be no visual indication of failure at the unit, but the protection afforded would still be equivalent to that provided by spring-loaded double check valves. With reasonable maintenance, there is little chance of backflow through a reduced-pressure backflow prevention device.

Assignment 4—Inspection and Maintenance

It is recognized that all backflow prevention devices should be inspected and field tested for correct operation at stated intervals. The initial test of reduced pressure devices should be within 90 days from date of installation. If found to be operating correctly, the unit should be placed on a minimum test schedule at intervals not to exceed 1 year. More frequent tests should be required where the device shows evidence of obsolescence due to water quality, operating conditions, age, or some other cause.

A complete overhaul or a thorough internal inspection in place, with replacement of facings and any parts showing wear, should be made at least once every 5 years or more often, depending upon design, the type of service, and condition of water being used. If any yearly test discloses any malfunction of the device, it should be repaired immediately.

An indicator that will show the need for maintenance of any part vital to proper operation of a device has been built in, and evidence of impending failure will be given by visual discharge through the atmospheric port from the differential relief valve. In the event these units cannot be located in places where this discharge would be immediately noticed by an operator, it is recommended that visual inspections be made on at least a monthly schedule, or more often if necessary, in order to assure that the equipment is functioning properly. An alarm or indicator could be used to supplement the inspection schedule, but it should never be considered a substitute for inspection.

Assignment 5—Applicability

The problem of the use of backflow preventers to protect the public and private domestic systems is one that cannot be clearly defined by this committee. It requires mutual agreement as to policy and the cooperation of the health authorities, the water purveyor, and the customer, or user, of the water. In practically every instance the health authorities have an overriding responsibility for the protection of both the customer's private piping system and the public potable-water supply system. It would be a physical impossibility, however, for the health agencies with their usually limited staffs to secure complete protection of the public and private systems without the cooperation of the water purveyor and the customer. Many health laws are predicated on the policy of requiring the water purveyor to be responsible for the protection of the public system and the customer having the responsibility for protecting the private system, with both programs coordinated by the health authorities. It is the

opinion of this committee that this is a reasonable approach to the problem; under such an arrangement, harmonious relations can be maintained among the three.

At the present time, there is no standard practice observed by all states or local governing agencies with regard to separating or protecting potable-water supplies from nonpotable supplies. Therefore, the committee recommendations for the location or the application of backflow prevention devices are subject to state or local laws or regulations.

There are two basic applications for the backflow prevention equipment. The first basic use is in the protection of the potable-water supply in the mains by the installation of backflow prevention devices at the water service entrance (usually near the meter) into an establishment also maintaining a nonpotable-water supply, or a potentially hazardous process fluid system. The second basic use is to provide protection within the consumer's premises for the potable water in the building distribution system in order to insure that it be kept safe for drinking, culinary, or washing purposes.

The type of backflow protection device to be installed in the potable-water service to a building or plant that also maintains a nonpotable supply should be determined for each such location by the local or state health authority, or, if such authority is delegated, by water purveyor. Air gaps and tanks are seldom used for this purpose, due to the pressure loss and pumping costs involved, although this method might be the most positive protection if never bypassed and otherwise properly maintained. The backflow prevention devices that have been used for this purpose have been the double check valve assembly and, in more recent years, the reduced-pressure backflow preventer. The reduced-pressure backflow preventer offers a greater degree of protection than the double check valve.

The degree of hazard present in the establishment being protected and the available main pressure are two of the factors that should be observed by the local authority in specifying the type of protection needed on a water service connection. In considering the installation of a new service by the water purveyor, the authority having jurisdiction over the safety of the water supply should evaluate the water use requirements of the prospective consumer to determine the type of backflow preventer required. A backflow preventer of the reduced-pressure type or an air gap separation should always be installed at the service connection where the known hazards are great, even though the potable systems are segregated from the nonpotable systems in the plant or facility.

In the event the customer elects to provide two or more services to premises in which hazards exist, a backflow preventer should be required on each service connection. It should be pointed out that the local authority may recommend the installation of double check valve assemblies on service connections in addition to the protection provided within the establishment. The local authority may also require an air gap separation instead of a protected cross connection if, in its opinion, it is warranted. In instances where the nuisance or pollution would not result in a major health hazard or extreme damage to the system, the authority may accept a double check valve assembly at the point of cross connection.

The industrial plant or other type of facility that maintains a secondary, nonpotable-water supply or other hazardous fluids as a pressure piping system must also protect the quality of the potable water in the facility itself. Backflow of polluted water through an unprotected cross connection within the facility may cause more people to be affected within the premises than outside. It is, therefore, necessary for the health or plumbing authority, and sometimes the water purveyor, to inspect the piping systems periodically within the premises, to see if proper precautionary measures are being taken in the establishment to separate or to protect existing cross connections between potable and nonpotable systems.

In industrial installations, one of the methods of protection that is sometimes used is to divide the customer's distribution system into two or more sections—one portion being used for domestic purposes and the other for industrial uses. This can be accomplished by installing, within the system, the appropriate backflow prevention device at a point where a separation is desired between the two uses, thereby protecting from pollution or contamination that portion of the customer's water piping system that should remain safe for human consumption. Plumbing or other types of cross connections should be eliminated from the potable lines within the system. As already indicated, it would also be necessary to install an additional backflow preventer at the service connection if the system were in a large establishment in which frequent changes and hazardous materials were used on the premises. In addition, the responsible authority should recommend other precautionary measures to be taken, such as the painting in distinguishing colors or the tagging of the potable and nonpotable systems, with warning signs against drinking posted near all nonpotable outlets.

The following examples of backflow preventer installations are listed as a guide to their many applications:

Reduced-Pressure Backflow Preventers

1. Reduced-pressure backflow preventers can be used on potable-water connections to establishments maintaining an unapproved water supply (as might be obtained from a river, lake, harbor, creek, or unapproved well) or water from an approved source that has been used and thus become contaminated before reuse. This is a "second line of defense" at the meter, and no physical connection should exist in the establishment unless protected by a method or device acceptable to the local authority.

2. In areas where swivel connections are allowed as a means of keeping a nonpotable and a potable supply separate, a reduced-pressure principle backflow preventer on the potable-water supply near the swivel will give protection for the short period of time required to balance pressures after the swivel device has been switched from the nonpotable supply to the potable supply.

3. Pierhead outlets of a potable-water system can be protected from backflow from ships maintaining fire pumps, which pump from harbors or other contaminated sources, by installing this type of backflow preventer at each pier outlet or hydrant.

4. In industrial plants the potable-water piping system can be isolated or "industrialized" to certain operations, such as a plating department with its multitude of submerged supplies, by

the installation of a reduced-pressure backflow preventer on the water line before it enters the "industrialized" area. Separate potable-water lines should be used to bring drinking water to the same area. Protection in isolated areas can also be used in distilleries, breweries, rubber plants, and many other types of industries.

5. Where chemicals hazardous to health or injurious to the potable-water system are manufactured, processed, or used in a manner which might lead to contamination of the public potable-water supply system, this type of backflow preventer can be installed at the service connection and also in special hazardous areas within the plant.

6. The reduced-pressure type backflow preventer can be installed on the potable-water supply lines to areas where oils or gases are produced, developed, refined, or transmitted in a pipeline. Other oil industry areas that may need protection are: oil tank farms, transmission lines (in the drilling operations for new wells), and producing wells.

7. A reduced-pressure backflow preventer can be used to protect the potable-water supply to a swimming pool. Direct cross connections to other systems where the degree of hazard is low can be protected by backflow preventers of this type, if authorized by local or state authorities.

8. This type of backflow preventer can be used for protection on *temporary* water lines used in testing or flushing contaminated water lines or sewers. It may also be installed on the potable-water lines into sewage-pumping stations or treatment plants.

Double Check Valve Assemblies

1. Double check valves can be installed on the water service connections where the local authority feels that they are adequate to protect the public potable system from mass backflow where cross connections are not allowed but might possibly be made.

2. The double check valve assembly is used in conjunction with the swivel connection in certain installations, such as spray towers, by some local authorities, to prevent backflow after a changeover to the potable system is made.

3. The double check valve assembly can be used to protect against backflow of steam, air, food products, beverages, and other materials that might constitute a nuisance hazard but not a health hazard.

4. Some state and provincial health authorities in the United States and Canada permit the continued use of existing cross connections when protected by double check valves. Most of these states and provinces, however, will not allow any new cross connections to be created.

It should be understood that in all of these examples of applications of backflow preventers an air gap and tank, or properly protected and supervised separate systems, could be substituted for any of the applications listed if, in the opinion of the authority, such additional protection is necessary. In the separation of water systems, however, there is always need for a second line of defense at the meter to protect against accidental connections being made between systems. There is also more incentive to bypass an air gap and tank than a backflow preventer that does not dissipate all available pressure from the potable source. In choosing between a reduced-pressure backflow preventer, an air gap separation, or a double check valve assembly, the principle

that should be applied is that the degree of protection should be commensurate with the degree of hazard.

Assignment 6—Installation

Any backflow prevention device must be correctly installed in a satisfactory location to insure proper maintenance and operation. There are problems involved when: [1] the backflow preventer is located at the meter on the service connection, and [2] the device is used to "industrialize" a line connected to the private water system.

When the device is for the purpose of providing protection to the public potable-water supply system, it should be rigidly installed, true to its horizontal and vertical axis, and located, if at all possible, above ground and adjacent to the meter. No service line or connection should be allowed between the meter and the backflow prevention device. There should be no unprotected bypass around the backflow prevention device. If, at any time, it is necessary to install a branch connection between the backflow prevention device and the meter for industrial or domestic use, a comparable backflow preventer should be installed on the new line as well.

The backflow preventer should be accessible for testing, maintenance, and overhaul. In nonfreezing areas the device should be located above the ground or in well-drained vaults, cellars, or other housing. In freezing areas the device should be located in a heated building, basement, or housing. Devices utilizing the reduced-pressure principle are particularly well adapted to outside and aboveground installation in nonfreezing areas. Units may readily be located in basements or other locations where the amount of waste from the relief would do no damage. In areas subject to freezing, outside installations in pits may not be practical, due to the necessity of raising the relief waste outlet aboveground and the difficulty of preventing the waste outlet from freezing. In the event the device cannot be located elsewhere than in an undrained vault or pit, the relief valve drainoff may be raised in such a manner as to permit discharge above the flood level of the surrounding area, if in a nonfreezing location. Flow from the relief valve discharge should not be obstructed by capping or plugging.

The installation and use of a backflow prevention device at the point of cross connection in an "industrialized" piping system become more complicated. To "industrialize" a line in a consumer's potable-water piping system is to segregate it from other lines carrying potable water. This is done by the installation of a backflow prevention device at the point where the industrial line is cross-connected to the potable line. In most situations involving the industrializing of lines it is possible to install the backflow prevention device within building areas, which will solve the freezing problem. Locations where the device would be subject to flooding or to corrosive fumes or sprays, however, should be avoided. As periodic tests and maintenance must be a part of any backflow prevention program, it follows that any backflow prevention device must be installed or located where tests and repairs can be made conveniently. The more inaccessible the device, the greater is the tendency to avoid proper tests and maintenance, and a little thought in advance when selecting the location of a device will pay dividends.

The industrialized piping system should be identified by installing signs at all outlets showing that the water

being discharged from them is either nonpotable or subject to contamination. The industrialized lines should be painted in such a manner that there is no danger of their being inadvertently tapped for domestic purposes. It should be emphasized that consideration must be given to the need for periodic inspection and occasional overhaul of the device, which will necessitate at least a temporary shutdown of service. If uninterrupted flow must be maintained on any service, it is recommended that two devices be installed in parallel, so that one device may be in operation while the other is being tested or repaired.

In the reduced-pressure principle backflow prevention device the pressure differential relief valve will discharge to atmosphere when: [1] a backflow condition takes place, and [2] the device needs repair. Therefore, it is important that the backflow unit be installed in a location where this discharge may be readily observed and where no damage can result from such discharge.

Analysis of the Backflow Problem

The committee has endeavored to evaluate past reports and the overall situation, with special emphasis on the suitability and use of the more currently developed backflow prevention devices.

Pure drinking water is a vital component of life; always to maintain a potable-water supply through the vastly complicated public and private pipelines of the nation today is a tremendous undertaking. The committee recognizes the value of completely separated and independent systems of piping for domestic and industrial water supplies, provided there is a positive assurance against interconnections being made between such systems. In this great maze of piping there may be a number of points where contamination may enter the potable supply. The degree or amount of pollution that enters or may enter the potable supply through these cross connections or plumbing interconnections, can vary from zero to that which would irreparably damage the water distribution system or would be instantly lethal to human life. In any event, the common goal in the control of cross connections is to protect the water supply and the system from the harmful effects of pollution or contamination in *any* amount. The protective device or method used to attain that goal should offer the utmost safety in this respect.

Although this report is primarily concerned with only those cross connections that cannot be satisfactorily eliminated except by air gap separation or other adequate protection, other types of protection required on less hazardous cross connections will also be discussed. It is currently possible, with the information and facts now available, to determine the correct type of protection that should be required for any given degree of hazard which might be encountered at any point of cross connection through which pollution could enter the potable-water supply. Once the degree of hazard has been established by a competent authority, it is relatively simple to prescribe an appropriate device to prevent backflow or back siphonage. An attempt has been made in this report to classify the use for which each recognized device is suitable. Each device

will operate within certain clearly definable limitations. By balancing these limitations against the hazards that are involved, it becomes possible to determine the proper device for each application. There is still a need for uniform classification of devices.

Health and water authorities have the continuing responsibility for preventing the possibility of pollution of the public and private water supplies as a result of backflow through *any type* of cross connection.

Difficulty of Complete Elimination

Experience has shown that it is physically and economically impossible to locate and eliminate permanently all cross connections within most customers' private distribution systems. Aside from the initial cost of a survey, there are other factors that must be recognized as having an important bearing on the matter. First, it is difficult and time-consuming to make a complete and thorough survey of piping within the larger and more complicated industrial plants. Many cross connections are hidden within various kinds of water-using equipment, walls, underground, or in other out-of-sight places where they may not be detected. Second, the industrial customer's system seldom remains unaltered for a satisfactory length of time. Piping or equipment changes are frequently made, usually without requests for inspection, and may result in the creation of new cross connections. Third, unless responsible health and water authorities maintain a continuing and adequate cross-connection inspection program at an excessive cost, it would be physically impossible to prevent unprotected cross connections from being installed.

Of primary importance in evaluating the entire cross-connection problem must be the realization that some cross connections could be allowed to exist, provided they were protected in such a fashion that they could not pass contamination into the potable supply. Most cross connections are made or proposed because they serve a purpose in water-piping systems which cannot generally be accomplished as economically in any other manner. To deny the water user this benefit and to refuse him the right under any circumstance to maintain a mechanically protected cross connection is to invite him to create the hidden, illegal cross connection from which there is no protection whatsoever.

Some authorities may find it difficult to concede that a cross connection may safely be allowed to exist provided it is adequately protected. It has been, and still is, proper sanitary engineering practice to *eliminate* as many cross connections as possible. Where customers have found it impossible to get along without them, consent for their use has been granted on a temporary basis, provided they were protected by the best and only known backflow equipment available at the time—up till the recent present, this has usually been double check valves. It has been realized for several years that installations of commercial double check valve assemblies do not afford adequate protection when applied to the average industrial or commercial type of cross connection. This was particularly true where the double checks were called upon to protect a potable source from a hazardous nonpotable supply. The only safe solution was the air gap separation system which served to create two separate piping systems. Such a solution was costly to install and main-

tain, however, was subject to intermittent bypass, and was usually responsible for the complete loss of original line pressure, necessitating continual repumping.

The fact that installations of commercial double check valves and air gap separations constituted the only means available of controlling the hazards of cross connections was sufficient reason for the universal attempt by the authorities to achieve the unattainable goal of complete elimination. Many previous reports and papers dealing with the general problem of cross-connection control, including the 1942 AWWA committee report (*1*) with respect to the smaller sizes of check valves, have recognized the necessity for improvement in backflow prevention equipment. Many leading authorities have recommended that steps be taken to accomplish this improvement. Shortly after the issuance of the 1942 AWWA report, certain industrial firms undertook the work of designing and producing backflow prevention devices containing built-in safety features. The additional safety factors incorporated into these devices are beyond those available in double check valve assemblies and appear to warrant a revaluation of the need for total cross-connection elimination where the use of such equipment is practical. The industrialists' answer to the problem was the reduced-pressure backflow prevention device.

Previous Recommendations

In the charge to the committee it was suggested that previously published committee reports be used for reference. The basic facts have been brought out and stressed in these reports (*1, 3, 4*). They have been reviewed with interest and, although each of them was important when published, it is realized that they are now partially outdated. It is believed desirable that this committee offer for consideration the present-day thinking in regard to the recommendations contained in the 1942 committee report. The former committee recommended the adoption by the Association of four expressions of policy with respect to cross connections. The recommendations presented at that time are so important, in view of the present thinking on cross-connection control, that they are quoted below. Following each recommendation are comments as to their applicability at the present time.

Recommendation 1

No new cross connections should be permitted between potable supplies and nonpotable, or unapproved, supplies. Existing cross connections should be eliminated in the shortest practicable time, but where immediate elimination is impracticable, such connections should be made only through approved, all-bronze, double check valves, properly installed, regularly tested, periodically and thoroughly inspected, and cleaned and repaired when necessary.

This recommendation was obviously based on the principle of complete elimination. The value of complete elimination is fully appreciated. If the use of properly maintained, approved reduced-pressure principle backflow preventers is to be recognized as providing adequate protection on hazardous cross connections, however, the recommendation has less importance than it formerly had.

The preceding section of this report briefly outlines some of the more dangerous hazards to a water system. It

will be noted that not all of these are health hazards and that some are system hazards. The reason for this differentiation is that from the health authorities', and to a lesser degree the water purveyors', standpoint a cross connection would be considered as being hazardous or dangerous if, under any circumstances, it might adversely affect public health. The water purveyor must also give consideration to the protection of his distribution system from the introduction into the system of substances which would deleteriously affect the quality of the water or cause physical damage to the facility. These substances could be in the nature of oils, muds, glycerine, paraffin, starch solutions, steam, beer, brines, soft drinks, and many other liquids, solids, or gases. These substances may or may not directly affect the public health but would adversely affect the water quality or damage the system, and in so doing cause an economic loss. Therefore, there is need for different types of protection to prevent introduction into the potable-water system of nonhazardous but objectionable materials and materials of a definitely hazardous nature.

During the past 25–30 years there have been enacted innumerable laws, rules, and regulations prohibiting the creation and maintenance of cross connections. These laws were apparently passed with the philosophy that "where legislation prohibits cross connections there will be no cross connections." In some instances, subsequent to the passage of such legislation, more-or-less elaborate enforcement programs have been put into effect. Experience derived in controlling cross connections under such legislation has shown that for all practical purposes it is impossible to legislate cross connections out of existence, even though the laws or regulations are accompanied by good enforcement programs.

Industry has the right to use the water it buys under pressure to the greatest advantage in its industrial processes, provided that no hazard is created. It is the duty of the water purveyor and health authorities to see that devices or methods are employed which will provide for adequate protection from backflow into the public and private potable-water systems. A cross connection protected by an appropriate backflow preventer may be maintained with safety, and there is a need for legalizing such cross connections. When this is done, industry may more effectively use the water as it is delivered, under street main pressure, without the need for temporarily or inadvertently installing unprotected cross connections. Under a program of this kind it becomes the duty and responsibilty of the water purveyor and health authorities, in cooperation with the industrialist, to insure a proper segregation of industrial waters from the domestic waters. They should insure the installation of approved mechanical backflow preventers, and adopt a properly administered installation, inspection, and maintenance program.

There should be uniformity in the formulation of regulations for effectuating control over cross connections and for enforcement of the regulations. For example, the California Municipal Utilities Assn., an organization for the protection of municipally owned utilities, recently appointed a committee to investigate the feasibility of providing for a uniform application of state and local cross-connection regulations for use by its members. On Mar. 25, 1954, its legislative committee recom-

mended to all members operating a water system that they adopt a standard procedure relative to the installation and use of backflow prevention devices. The recommendation was strengthened by the issuance of a letter which stated the rule and administrative procedures to be used in carrying out the program. The committee also made accessible to the members a list of acceptable backflow prevention devices. These devices have been tested, evaluated, and approved by the USC Research Foundation for Cross-Connection Control.

Recommendation 2

In cases where industrial or other establishments have separate supplies of potable and nonpotable water distributed through independent systems of piping, without known cross connections, consideration might well be given to providing double check valves . . . on the service pipes leading from the public mains. This would mean the development of improved designs for check valves in the smaller sizes more reliable than those now available. In any event, the pipes of the two distribution systems should be painted distinguishing colors to reduce the chance of making cross connections through ignorance.

In this recommendation the 1941 committee suggested that "consideration might well be given to providing double check valves . . . on the service pipes leading from the public mains." This recommendation is just as valid today as it was then—with the exception that there have been additional developments in the mechanical devices now used as backflow preventers. Here again, consideration should be given to the degree of hazard involved in the selection of devices and in judging their suitability for use at the service connection. This is the responsibility of the health authorities and water purveyors, and it is essential that a comprehensive program be provided for uniform application of this policy.

Recommendation 3

High-pressure public fire systems, when supplied from nonpotable sources, should have no direct connection with the domestic-supply mains. During the present period of national emergency, however, the continued use of existing systems now cross-connected may be tolerated, if the protection afforded by the approved type of double check valve installation is provided under authorization by the appropriate water and state health officials.

Every possible effort should be made to avoid interconnecting public, nonpotable, high-pressure fire systems with public water systems supplying domestic water. The reduced-pressure backflow preventer may fill a need during certain times of emergency only.

Recommendation 4

Fire protection programs should not include pumping from polluted sources into public mains through hydrant connections.

This recommendation is still valid, and it is inconceivable at this time that anyone would consider it expedient to endanger human lives by pumping polluted waters into public mains through hydrants or other types of connection. By proper planning this practice should be unnecessary.

Preliminary Evaluation of Devices

The committee feels that all mechanical backflow preventers—whether they be double check valves or backflow preventers operating under the

reduced-pressure principle with all built-in features to indicate failure—should be evaluated by the staff of a competent laboratory. This is borne out by the experience of the Research Foundation for Cross-Connection Control at USC. The foundation has established a laboratory for the express purpose of testing and evaluating mechanical backflow preventers. The laboratory is staffed by well-qualified engineers and equipped with all the facilities necessary in the study of design, materials, operation, flow, and head loss characteristics. This group of engineers has been active in research in the fields of cross-connection control for approximately 10 years, and during that time it has conducted laboratory and field tests of approximately 5,000 backflow preventers of all types.

It has been found that uniform results cannot be attained when just any type or quality of check valve is used in a backflow prevention device or in double check valve assemblies. It is a fallacy to think that dependence can be placed on a "bargain counter" check valve that has been improperly designed or fabricated from inferior materials. There are some very good check valves that are usable as purchased, and there are some that can be satisfactorily modified. The great majority of commercial check valves are not adaptable as purchased, however; neither can they be modified with any degree of satisfaction. It is important that a testing agency be established for the purpose of evaluating the check valves used in backflow prevention devices.

It is generally not feasible for the average water purveyor to test and evaluate a backflow prevention device in his own shop, due to the lack of necessary specialized pumps and equipment or of operators trained in this highly specialized field, or because the purveyor does not wish to assume the responsibility for approving such devices.

In the interest of uniformity, it would be desirable for AWWA and CSSE—and such other agencies as may be interested—to sponsor and certify qualified laboratories at strategic locations throughout the United States. Such laboratories should be staffed with qualified personnel and equipped with circulating and vacuum pumps, meters, manometers, and such specialized equipment as may be necessary for determining the operating characteristics of any device, including rates of flow and head loss. The laboratory should also be required to evaluate the materials and design of the device and to conduct tests to determine its servicing and maintenance requirements. The laboratories should formulate and closely follow uniform specifications for backflow prevention devices and the methods of testing. Devices should have provisional approval after they have passed a comprehensive laboratory test and have operated satisfactorily under service conditions for a specified period of time. Final approval should be withheld until field experience has indicated the device to be satisfactory. All manufacturers of backflow prevention equipment should be required to have stock samples of their devices certified and approved by such laboratories. Equipment designed for use on fire service connections should also have fire underwriters' approval.

Maintenance

It is a recognized fact that no mechanical device of any type, regardless

of how carefully or precisely made, will continue to function satisfactorily without adequate maintenance. This is true not only of mechanical backflow preventers, but also of air gap separation. Only constant vigilance will insure that somebody has not put a hose into the receiving tank or has not otherwise bypassed the air gap separation. It is also necessary to insure that the mechanical backflow prevention devices are tested and maintained in a satisfactory manner. For this reason, a testing and maintenance program is an indispensable feature of a cross-connection control plan.

In the establishment of an inspection, maintenance, and reporting program, the frequency of inspection of backflow prevention devices should be based on the experience with each particular device involved. It has been found that, occasionally, a new device of a reliable type or kind will fail to operate satisfactorily during its initial test run after being installed—often because of foreign objects introduced during installation and lodging under the seats, or because of other minor mechanical defects. After the device has been installed and has had its initial test, if it is properly designed and the highest grades of materials are used in its construction, it should operate effectively and positively for at least a 3-month period. At the end of this period, if the device is tested and found to be operating satisfactorily, the test period may be extended at the discretion of the certifying authority for a period up to 1 year.

As far as maintenance is concerned, it should be performed at the time of the test if there is an observable need. Under normal conditions, the device should be overhauled at the end of each 5-year period. It may be necessary to overhaul it more often if the water is highly corrosive or heavily mineralized. It is recommended that design changes be made to eliminate, if possible, any necessity for removal of devices from the line for overhaul.

Air Gap Separation

Although it is recognized that the air gap principle is generally considered basic in affording maximum protection against backflow, it should also be recognized that it can easily be bypassed and its effectiveness thus entirely destroyed. Actually, it sometimes does not afford the reliability assumed with its installation. It is believed that practically every air gap separation that has ever been installed at the service connection has been, or will be, bypassed at some time during its lifetime as a result of an emergency, or for some other practical reason. Some common excuses are: "the pressure went off," "it needed to be replaced," "the pumps failed," or "the power failed." An examination of the air gap separation method used as a backflow preventer will disclose many inherent drawbacks in connection with its use for cross-connection control purposes.

From a consumer cost standpoint, the installation of a suitable elevated gravity tank or a ground level receiving tank, an adequate pump, a float control system, electrical transmission lines or other power means, together with additional piping and space for housing, will all too frequently add up to a cost that is unreasonably high when compared to modern mechanical backflow prevention devices, and the result offers no more security. This is particularly true in the larger installations where repumping equipment

becomes extremely costly. To this consumer investment is then added a monthly bill for power, maintenance, repair, or replacement of equipment. Of primary concern to the water consumer is the fact that he is being deprived of the water pressure in the main, for which he has paid, either directly or indirectly, and in addition, he is being forced to install an elevated gravity tank, or to establish and maintain his own private pumping plant, or both. This is an incentive to bypass the air gap arrangement. In the event of a power failure an emergency may be created, as no water under pressure would be available. If a continuity of water supply is required in the plant or industry involved, something would have to be done at once. Obviously, the quickest solution would be to bypass the entire tank and pump and use the water under pressure directly from the main.

In places where such power interruptions are fairly frequent, or on occasions where even a temporary water shortage would be dangerous or costly to plant operation, it is often customary to maintain, permanently in place, a valved-off bypass or a bypass with a removable section or spool that can be inserted in the line on short notice. Unfortunately, plant operators seldom take the trouble to remove the spool, once it has been installed. The valved-off bypass is an open invitation to leaking valves or operational mistakes lightly referred to as the "human element." In either event, the air gap system immediately changes from full protection to a dangerous hazard. This hazard is not readily understood by the operator or customer. He usually does not realize that most waterborne-disease outbreaks resulting from backflow of contaminated water in potable systems have occurred as a result of bypasses, open or leaking gate or check valves, or emergency cross connections made for periods of short duration.

In addition to the unexpected or accidental air gap equipment failure, there are the bypasses installed prior to periodic overhaul, when the receiving tank must be drained for cleaning, scraping, painting, or repair. This calls for deliberate bypassing of the installation for considerable periods of time—again eliminating the overall protective value of the air gap system during such periods. Most bypasses are installed because the operator does not realize the danger involved; there are some operators, however, who are negligent. There are others who, with full knowledge of the hazard involved, deliberately bypass their air gap equipment soon after it is installed, use the water pressure directly from the main, and thus save on monthly power bills. These situations are discovered only by frequent and costly inspections conducted by the enforcing authorities.

Splashing at the inlet to the receiving tank often occurs, which may cause the tank walls and surrounding area to be moist constantly. This may increase corrosion and structural damage, and it is also favorable to the growth of bacterial slime and the breeding of insects.

Careful analysis of these and other points discloses the fact that the air gap separation system sometimes does not meet the generally accepted idea of full protection. It is not, as some believe, an entirely safe means of controlling or eliminating cross connections, because it cannot always be depended on, and, if used where health hazards are particularly dangerous, the system should be under frequent offi-

cial inspection and regulation just as other mechanical devices.

It is believed advisable that, on all air gap installations protecting a potable-water supply to a plant where shutdowns would cause costly damage, duplicate facilities or an approved substitute, such as a suitably protected swivel connection or a four-way valve, should be provided.

Single Check Valve

The common swing check valve was the first type of mechanical device designed to prevent the backflow of fluids automatically, although it no doubt followed the use of the air gap or stop valve as a means of protection. Through many years of experience, in which there have been frequent failures, it has been found that a single check valve does not afford sufficient reliability in protecting potable-water supplies from contamination. Evidence of failure is not immediately apparent. In many industrial applications several check valves have been found in series, which were installed successively because of failure of the other previously installed checks. It has, therefore, been found necessary to use something more reliable than a single check valve, regardless of its type.

Double Check Valve Assembly

Double check valve assemblies are at present conditionally acceptable to several of the state health authorities and some municipalities. Consideration should be given to the history of the development of the special-type double check valve assemblies that have been used on a large number of industrial and private fire service connections to public water systems. The realization that single check valves could not be relied on for long, unsupervised periods was, no doubt, responsible for the evolution of the double check valve combination as a backflow-preventing device. The placing of two check valves in series in a potable-water line, adjacent to the point where it is connected to water of doubtful quality, should, presumably, provide more reliable protection against backflow than would be provided by a single check valve. There are many types of check valves, both swing and lift. There are definite differences in their design, quality, reliability, and length of life.

Prior to 1906, the Factory Mutual Inspection Department (now the Factory Mutual Engineering Division), health authorities, water purveyors, and others became concerned with the possibility that public water systems might become contaminated as a result of backflow through commercial-type, metal-seat-to-metal-face check valves. The result of this concern was the early development of the iron-bodied, flat rubber-faced disc check valve, in which the seat was set at such an angle from the horizontal as to give some weighting effect to the disc. This minimized the likelihood that the disc would ride in a floating position when pressures on both sides of the check were equal. Two of these valves, equipped with gates and drains to permit tightness tests, were installed in series, usually with a 3–5-ft spacer between the check valves. Interiors of the iron bodies were japanned to minimize corrosion.

Experience with this earlier iron-bodied check valve indicated its performance to have been reasonably satisfactory. Frequent painting of the body interiors was necessary, however,

to prevent formation of products of corrosion. An improved design was developed and adopted as standard in 1926. This valve was constructed entirely of bronze, eliminating the need for periodic cleaning and painting the interior of the iron body. In addition, greater clearance was provided under the seat than was available in the previous design, and the disc was equipped with a dome-shaped, flexible, molded-rubber ring. This ring, on initial closure, makes a hairline contact with the seat, and with excess back-pressure on the discharge side of the valve, the line of contact broadens. Also, as a result of the flexibility of the ring, small deposits on the seat do not necessarily cause leakage. These check valves, trimmed in a manner similar to the iron-bodied check valves, were installed in series. It is believed that this type of valve could be adopted as standard for use in double check valve assemblies where no unusual health hazard exists.

Originally, the iron-bodied bronze mounted valves, and subsequently the all-bronze check valves, were recognized or accepted for use by approximately one-half of the state health authorities, principally in highly industrialized states. Because these double check valve assemblies were designed specifically for the purpose, however, such acceptance was generally limited to fire service connections existing at the time of promulgation of state cross-connection regulations and in accordance with recommendations of the AWWA and NEWWA cross-connection committees. In supervising double check valve equipment of this type it has been the practice to make periodic tightness tests and internal inspections. Molded-rubber facings have been determined to have an expected life span of 6–7 years. Replacement of the molded-rubber facings at 5-year intervals is recommended.

With all the time, effort, and money expended in the development and improvement of the present-day check valve, no check valve has yet been devised which can be guaranteed against leakage—whether it is used singly, in pairs, or in greater combination. Every double check valve assembly has the inherent weakness that it can fail without giving any indication that failure is occurring. Hence, reliance should not be placed on such a device where the hazard is great, and positive protection against backflow is essential for the prevention of health or system hazards. Even the periodic inspection of double check valves will not insure that leakage will not take place at some period between inspections.

In spite of all this, double check valve assemblies still have their place as a second line of defense against mass backflow, and their use may be allowed where the health or system hazard involved is not great. They may be used to protect against the backflow of water, steam, air, beverages, or other materials which do not constitute a direct health hazard. For approximately 20 years it has been the practice of the health and water authorities and fire protection interests not to recommend the creation of any new cross connections between potable- and non-potable-water supplies. This policy should be reviewed, in view of the improvement in mechanical backflow preventers. A standing committee should reclassify, in view of more recent experience, air gap separations and backflow preventers operating under the reduced-pressure principle as to the type of hazards they can be used to

prevent. The all-bronze, special, fire service, double check valve assembly, possibly modified to have some increased opening-moment pressure in the direction of flow, should also be reexamined to determine its applicability as a protective device.

Superior-Pressure Type Backflow Preventer

The necessity to improve the efficiency of the double check valve assembly brought out the incorporation of an automatic drainoff valve between the check valves, which was arranged so that it opened and drained the line between two check valves as soon as the pressure on the downstream side of the valve assembly exceeded the upstream pressure by a slight amount, sufficient to operate a pilot valve and apply pressure to two diaphragm-operated check valves. The following is quoted from the USC research foundation report (*2*):

> This device incorporates within its structure a zone located between two check valves. Under a backflow condition, the pressure in the zone may become higher than the inlet pressure, and in case checks are leaking, water will backflow through the inlet into the supply line. Under this condition, the differential pressure relief valve may or may not be draining to the atmosphere. In any event, the differential pressure relief valve is of questionable value, and the use of this device is not recommended.

It is believed that the use of the superior-pressure type differential pressure relief valve in conjunction with double check valve assemblies serves no useful purpose. It creates a feeling of false security, and the practice should be discontinued. The device fails in its intended purpose of preventing backflow or in dependably indicating that backflow is occurring. When both check valves in a double check valve assembly are leaking, and the upstream check valve is leaking as much as or more than the downstream check valve, no differential will be created. The superior pressure differential relief valve will not open and will not indicate that backflow is occurring. The device may also allow leakage to occur on low pressure differentials, which would not occur under higher differentials or where the full back pressure is exerted on the check valve.

Limited-Use Methods

The following devices are not true backflow preventers with universal application. They must be used either under atmospheric conditions or in combination with an air gap separation or an adequate mechanical backflow prevention device, because they are subject to failure when subjected to positive back pressure.

Barometric Loop

The barometric loop, which is simply a vertical loop of pipe rising to an elevation higher than a column of water can be forced by atmospheric pressure, has been utilized to overcome the loss of available pressure in some instances. The loop affords a continuous conduit for the potable water, the only loss of pressure being due to pipe friction resulting from the longer distance the flow must travel. The downstream leg of the loop is connected to the process equipment. The elevation of the top of the loop is usually about 34–35 ft above the highest outlet or outlets in the process equipment. The creation of a vacuum on the upstream side of the loop will not cause a column of fluid from the downstream side to be forced over the top.

There are several limitations to the use of the loop as a backflow prevention device. It is obvious that it could not be used where pressure tanks or pumps might create pressures on the downstream leg that would be greater than atmospheric pressure and cause the loop to lose its value as a barrier against backflow. Another limitation would be the difficulty of altering the elevation of the loop, if the outlet elevations were raised, in order to maintain an approximate 35-ft difference in elevation. The loop can also become an ineffective barrier if air is admitted to the downstream leg through multiple outlets or if some outlet is not submerged, thus permitting nonpotable water to be forced over the top of the loop by an "air-lift" effect.

The use of check valves in the loop, with vacuum relief at the top of the loop, would reduce, but not eliminate, this latter hazard. In any event, check valves would not always prevent backflow if higher pressures were developed on the downstream leg than on the inlet to the valve. It is also important that the pressure in the potable supply always be sufficient to overcome the head developed by the elevation of the loop. Otherwise, there would be intervals during which no water would be supplied to the building or equipment.

Lastly, because the loop must rise to the necessary height above the topmost outlet it supplies, there is the possibility that it would have to be located outdoors. In some latitudes, protection against freezing is required.

Swivel Devices

There have been a number of types of swivel, or changeover, devices used for the purpose of quickly changing over from one source of water supply to another. They are used to provide alternate, but not simultaneous, supply from either a potable domestic supply or a nonpotable auxiliary source. These changeovers include swing devices, swivel devices, four-way plug valves, and sliding multiport tubes either manually or hydraulically operated.

None of these devices should be classified as a backflow preventer in itself. They fail to meet the requirements of an approved backflow preventer. For a short period after the swivel has been switched from a nonpotable source to a potable source, it may permit the flow of nonpotable water into an approved water system if not protected by a backflow-preventing device. A backflow preventer or a double check valve assembly used in conjunction with one of these devices to protect the potable-water supply guards against this period of danger. Under such circumstances, if the backflow preventer or double check valve assembly is adequate when the degree of hazard involved is considered, the changeover device may be used safely. In this case it is the backflow preventer that is protecting the potable water supply and not the changeover device, but the device is separating the two supplies and the equipment is being supplied from only one source or the other. This may be an advantage, as leakage of water from either system into the other is avoided. The swivel also reduces the period of time that the backflow preventer must provide protection.

Conclusion

The conclusions and recommendations of the committee are divided into two categories: general conclusions and recommendations, having to do with the overall needs of the industry, and specific conclusions and recommendations, relative to the six specific assignments given to the committee.

General Recommendations

The committee finds that there is nonuniformity in the laws, rules and regulations having to do with cross-connection control, with specifications for backflow prevention devices, with their installation and use, and with the testing and maintenance of such devices. The committee also finds that the number and types of cross connections are rapidly increasing and that there is need for backflow protection at the service connection in order to confine pollution and contamination to the private piping system within the premise. It is recommended, therefore, that a *permanent* joint committee on cross-connection control, to include representatives from all interested groups or organizations, be established, with the following responsibilities:

1. To accumulate and evaluate information relative to present practices of cross-connection control
2. To prepare model preventive laws, rules, and regulations which would legalize protected cross connections
3. To prepare a standard practice manual for the guidance of agencies enforcing the laws, rules, and regulations
4. To prepare standards for backflow prevention devices of all types
5. To promote or investigate the possibility of establishing the certification of competent laboratories for the testing and approval of backflow prevention devices
6. To prepare timely reports covering the foregoing subject matter and distribute such reports to water purveyors and health authorities throughout the nation (The latest report on the subject prepared by AWWA was published in 1942 (*1*). An interval more than 16 years between reports on such a vital subject is excessive.)
7. To investigate the possibility of combining backflow prevention devices with the metering devices for use on water services to establishments which maintain secondary nonpotable-water supplies or hazardous processes which can be cross-connected to potable-water systems. Such a combination device has the possibility of materially reducing the head loss and the total cost of the meter and of protecting the potable water in the street main when such protection is deemed necessary by the health authority or water purveyor.

Specific Recommendations

Assignment 1. The reduced-pressure principle backflow prevention devices, as approved by the Cross-Connection Control Advisory Committee of Los Angeles and other local authorities, were found to be dependable if properly maintained. It is recommended that a standing joint committee prepare uniform standards on materials, design factors, and flow characteristics, in order to assure that hereafter all devices will be satisfactory.

Assignment 2. The friction losses have been commented on in the body of the report. The initial head loss that is built into the device, which constitutes the reduced-pressure principle, cannot be eliminated. It is believed, however, that by further streamlining the device, the overall head loss can be materially reduced. This would also apply to the relatively high head loss in many metering devices. It is recommended that the aforementioned standing committee be given the responsibility of negotiating with the manufacturers to accomplish a reduction in loss of head in backflow prevention devices.

Assignment 3. The clogging or breakdown of the reduced-pressure principle backflow prevention device can best be determined by observation of existing installations over a protracted period of time. Up to the present time, there have been no reported failures to prevent backflow due to clogging or breakdown in several thousand devices which have been in use for periods up to 15 years.

Assignment 4. Proper inspection and maintenance of the devices are essential factors of a good cross-connection control program. It is recommended that the standing committee prepare uniform standards for testing and maintenance procedures to be adopted by industry and regulatory agencies.

Assignment 5. The reduced-pressure principle backflow preventer has been found to be reliable under field conditions. It is, therefore, recommended that the reduced-pressure principle device be approved for use on a service connection and at such points of cross connection as are allowed by the state or local health authorities. Any of the committee's recommendations on the use or application of reduced-pressure principle backflow preventers is subject to acceptance by the state or local authorities having jurisdiction.

Assignment 6. There is no uniform practice followed by the industry in the location, installation, or protection of the device. The standing committee should prepare for distribution to health and water authorities and to the plumbing trade typical layouts for installations. They should also work with the manufacturers to provide for electrical or mechanical alarms for indication of discharge from the relief valve.

References

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Progress in the Toronto Distribution System

Ross L. Clark

A paper presented on Jun. 2, 1958, at the Canadian Section Meeting, Toronto, Ont., by Ross L. Clark, Comr. of Works, Metropolitan Toronto, Ont.

IT is the purpose of this article to describe the water supply situation at the time metropolitan Toronto was incorporated, to give a brief resume of the expansion program that has been carried out since that time, and to outline the steps being taken to match the rapid pace of development.

Toronto is a federation of thirteen municipalities, with an area of 153,000 acres, and has a population of 1,416,000, according to the most recent tabulation. It is 24 mi from east to west, nearly 15 mi north to south. Its southern boundary extends along the northern shoreline of Lake Ontario and its geographical location is the envy of many water supply engineers. The supply of excellent raw water is practically unlimited, provided that the lake is carefully protected against pollution, which it has been in the past, and, with the new Ontario Water Resources Commission, there is every guarantee that the essential restrictive measures will be continued in future years, if not improved.

Conditions in 1953

Immediately prior to the incorporation of the municipality of metropolitan Toronto, the thirteen member municipalities, shown in Fig. 1, operated seven sources of potable water and were capable of producing a combined total of 245 mgd for short periods. On a prolonged basis the figure would probably be somewhat lower, or about 235 mgd. The rated capacities of these plants are given in Table 1.

Had there been adequate distribution facilities, this total supply, including the undependable production from wells, would still barely have been sufficient to meet the overall requirements of the thirteen municipalities in December 1953. There was absolutely no reserve to provide for the increasing population, which was growing during that period at the rate of 36,000 persons per year.

A more serious problem than the lack of treatment plant capacity for future growth was the complete inadequacy of trunk mains and pumping stations to transport water from the existing treatment plants into the more rapidly expanding municipalities. Reservoirs located throughout the area for the storage of water to meet daily peak

TABLE 1

Capacity of Toronto Area Filtration Plants and Wells in 1953

Plant or Wells	Capacity mgd
R. C. Harris plant	100.0
Island filtration plant	100.0
New Toronto filtration plant	22.0
Scarborough filtration plant	14.0
North York wells	4.7*
Weston wells	2.3
Etobicoke wells	2.0
Total	245.0

* Includes approximately 1 mgd treated at Oriole plant, when operating.

demands provided only about 40 per cent of the capacity necessary for so vast a water system.

In general, the Toronto system was supplying enough water for its own requirements and those of Leaside, York Township, and the villages of Swansea and Forest Hill. It also provided limited amounts of water to East York, Scarborough, and North York.

in Scarborough would soon restrict delivery of water to East York.

Weston did not appear to be experiencing difficulty with its supply of water from wells, apart from the local nuisance caused by a relatively high iron content.

Etobicoke had a moderate supply of water from the recently enlarged Toronto plant, and a small supply of well water, but unprecedented development

Steeles Ave. Pumping Sta.
TOWNSHIP OF NORTH YORK
Oriole Pumping Sta. and Treatment Plant
TOWNSHIP OF SCARBOROUGH
Summerlea Well Treatment Plant
Sheppard Ave. Pumping Sta. and Treatment Plant
Dee Ave. Treatment Plant
Wilson Wells Treatment Plant
TOWN OF WESTON
VILLAGE OF FOREST HILL
Lawrence Ave. Pumping Sta. and Reservoir
TOWN OF LEASIDE
Martin Grove Pumping Sta. and Treatment Plant
YORK
High Level Pumping Sta.
TOWNSHIP OF EAST YORK
Warden Ave. Pumping Sta.
Scarborough Filtration Plant and Pumping Sta.
TOWNSHIP OF ETOBICOKE
VILLAGE OF SWANSEA
TORONTO
Riverdale Pumping Sta.
Parkdale Pumping Sta.
Victoria Park Pumping Sta.
R. C. Harris Purification and Pumping Plant
TOWN OF NEW TORONTO
TOWN OF MIMICO
John St. Pumping Sta., Marine Plant
New Toronto Filtration Plant and Pumping Sta.
Island Filtration Plant
VILLAGE OF LONG BRANCH
LAKE ONTARIO

Fig. 1. Toronto Area Facilities, 1953

The map shows the facilities existing immediately prior to the incorporation of metropolitan Toronto. Seven raw-water sources then served an area of 153,000 acres.

The New Toronto system, with the plant enlargement made in 1953, in addition to meeting local requirements, was delivering a sufficient supply to Long Branch and Mimico, and a moderate amount to Etobicoke.

East York, in addition to drawing water from the Toronto system, was receiving a supply from the Scarborough system. It appeared a reasonable assumption, however, that development

and population growth indicated a serious shortage was imminent.

Scarborough had completed a 10-mgd extension to its original 4-mgd filtration plant in late 1952, and, although there was a moderately sufficient water supply in December 1953, population growth in the township was phenomenal and indicated that a water shortage would be created in a very short time. There was also a lack

of trunk mains for distribution of the available water.

North York was in the most serious position of all municipalities, being faced with a lack of adequate distribution mains and production facilities, or alternative sources of supply. Besides producing 4.7 mgd from its wells and plant in the east and west branches of the Don River, the township was purchasing limited and insufficient amounts of water from East York, Scarborough, York, Toronto, and Weston.

Evidence indicates that each of the municipalities had endeavored to assist its neighbor in acquiring a proper water supply, but there had been no adoption of a coordinated master plan for new plants, pumping stations, reservoirs, and distribution mains, which was essential if a satisfactory system was to be developed.

In 1950, Toronto had commenced an extension and rehabilitation program for its system at an estimated cost of $10,133,000. This included construction of the Parkdale Pumping Station to improve distribution in the west end of the city, an extension and rehabilitation of High Level Pumping Station to improve pressures in the north end of the city, and the installation of large-diameter water mains in various locations. By December 1953, approximately 40 per cent of the program had been completed at an expenditure of $4,287,000.

'Operation Backlog'

Immediately after its inception in mid-1953, the Metropolitan Council engaged a firm of consulting engineers to revise and bring up to date a report which they had prepared in September 1949 on a proposed plan for water supply for the city of Toronto and its related areas. The conclusions and recommendations of their subsequent revised report, dated Jan. 30, 1954, formed the basis for a water supply improvement program, which was commenced in a matter of weeks by the council. This program is now designated as Phase 1, and it is commonly referred to as "Operation Backlog."

By July 1956, after 2½ years of concentrated design and construction, extensive work had been done on the enlargement and rehabilitation of those purification plants that were to become permanent installations, and a large number of new water mains had been installed. Although the accomplishments were gratifying, however, the program was not progressing rapidly enough to keep abreast of the accelerated development while catching up to the 15–16-year backlog of necessary facilities. In short, Operation Backlog was working in reverse.

Up to that time, approximately 20 engineers and numerous technicians had been engaged in the design of major water mains and in supervision of all construction, with a small number of consultants designing and preparing specifications for the major plant enlargements and rehabilitation then under way. Outside assistance was also being used on the plans and specifications for a limited number of pumping stations and reservoirs.

An evaluation of the situation indicated that approximately 200 engineers, with an unlimited number of technicians and inspectors, would be required if the backlog was to be eliminated before 1960. More efficient engineering techniques were also desirable.

The plan finally adopted to expedite completion of outstanding projects provided for the engagement of consulting

engineers on every line of endeavor. All scheduled water mains, pumping stations, reservoirs, and plant improvements, as well as conversion from 25- to 60-cycle electric power, which had not been started, were assigned for design, plan preparation, and complete construction supervision. Those works on which the department had previously prepared the contract drawings were assigned for construction supervision. For a 40-day period in 1956, agreements were being drafted and executed at the rate of one a day.

A project division was established in the department to cooperate and confer with each consultant to achieve uniform plan drawings, specifications, and construction supervision.

TABLE 2

Mains Assumed or Constructed by the Toronto Water System Since 1954

Year Constructed	Date Assumed	Length *ft*
—	Jan. 1, 1954	495,100
1954	—	10,334
—	Jul. 1, 1955	138,000
1956	—	68,241*
1957	—	92,740*
1958†	—	94,353

* These figures demonstrate the advantages of using consultants.
† Work completed in only 5 months of 1958.

Steel plate, pipe, valves, fittings, meters, and all appurtenances for pumping stations, such as diesel engines, pumps, and motors, were ordered well in advance of the construction period, and expediters were employed to make sure that delivery schedules were met. These employees made frequent visits to various points throughout Canada and the United States in the course of their work. Advance procurement of materials was made possible through the use of a capital inventory suspense account, which at times reached a value close to $3,000,000.

The program required the acquisition of many easements across private property, and, to facilitate the work, property officers were continually engaged by the corporation in preparation of property plans and consultations with private owners. Consent to construction across private property was usually obtained well in advance of settlements.

The full impact of the new procedure was felt in early 1957 when contracts were called, four or five at a time, every other week. Rigid construction schedules were drawn up and a constant, running conference was maintained with both consultants and contractors to help eliminate difficulties.

Throughout this period, soil borings that were necessary for either design or construction purposes were obtained on an emergency-tender call basis by the project division. A stock of steel sheet piling was maintained for installation where river crossings were involved.

With the prospect of opening approximately 30 mi of heavily traveled traffic arteries and streets, it was mandatory that each phase of work be carefully coordinated with each area engineer and the Metropolitan Traffic Engineering Department—all of whom were extremely cooperative throughout the entire period, under circumstances that must certainly have caused them many frustrations. Citizens residing in areas that would be affected by the construction were informed of the purpose and course of each project by circular letter, containing the names, addresses, and telephone numbers of officials who should be contacted in emergencies. The press and engineer-

ing and construction periodicals were given plans of the various works and were most cooperative in publicizing all phases of the program. Members of the engineering staff were available to service, church, and other groups, to show colored slides of all facilities under construction, and to answer pertinent questions.

Filtration Plants

After 4½ years, Operation Backlog is nearing completion. The capacity of water treatment plants has been increased from an original reliable capacity of 235 mgd to 355 mgd. Major extensions have been completed at the R. C. Harris and Scarborough plants. Contracts for rehabilitation of the Island Filtration Plant have been awarded, and work should be finished by the end of 1958, as well as certain improvements at the New Toronto plant. Electrical conversion from 25 to 60 cycles has also been completed, for the most part, in conjunction with plant extensions.

No major extension of existing filtration plant capacity will be required until perhaps 3 years from now, when additional installations will be necessary to meet increased consumption.

TABLE 3

Improvements, Rehabilitation, and Construction of Pumping Stations Since 1953

Work Done	Present Capacity *mgd*
New plants	
Parkdale	80
W. Toronto	35
Lawrence	35
Armour Heights	15
Royla York	15
Eglinton	49
Enlargements	
High Level	36.5
John Street	218
R. C. Harris	397

Water Mains

To date, 299,150 ft of new water mains, ranging in size from 24 in. to 48 in., have been laid. Table 2 describes the water mains that were inherited by the metropolitan corporation from the area municipalities, and shows the extent to which the distribution system has been augmented. Also, it indicates achievements after 1956, which resulted from use of the facilities offered by consultants.

Of the mains taken over by the metropolitan corporation from the local Area Municipalities, more than half were less than 24 in. in diameter. On the other hand, most of the new mains installed are 36, 42, and 48 in., and therefore capable of distributing considerably more water. In general, it can be said that during the first 4½ years of work, the capacity of the system will have been increased by more than 70 per cent.

Pumping Stations

Variations in level throughout the Toronto area make it necessary to maintain five and a half pressure districts and require adequate pumping stations to deliver water from one district to another. Rehabilitations and construction of new stations have been completed. These new or rehabilitated stations are listed in Table 3.

Reservoirs

An adequate water supply system requires reservoirs to meet periods of peak demand. Operation Backlog provided additional facilities to increase the original storage capacity. Although only a few of the reservoirs have been started, a new 30-mil gal

unit at Lawrence and Caledonia Road has been completed. This completely covered structure is a source of pride, in that it was in service only 11 months after construction was begun. It has played a significant part in meeting the severe water demands of North York and Etobicoke—two of the larger customers.

Dollar expenditure does not give an accurate index to work accomplished, but it does illustrate somewhat the extent of improvements in the system. The expenditure during 1957 and the first half of 1958 was $20,957,000. This exceeded the total expenditure for the three preceding years by over $300,000. The total for the entire period beginning Jan. 1, 1954, and ending Jun. 2, 1958, was $41,544,000. During this same period, 94 contracts were awarded for water utility projects.

TABLE 4

Improvements in Toronto Water Facilities Since Jan. 1, 1954

Date	Filtration Plant Capacity *mgd*	Trunk Mains *mi*	Distribution Pumping Capacity* *mgd*	Reservoir Capacity *mil gal*
Jan. 1, 1954	235	119.97	618	93.23
Jun. 2, 1958	355	176.67	831	123.23

* Includes standby and repump capacities.

The sales of water to the thirteen area municipalities reflect the benefits of Operation Backlog. Water sold to consumers in 1954 totaled 51.5 bil gal, whereas this year it will approach 58 bil gal, or an increase of 12.5 per cent, with the additional supply reaching those municipalities that have the most urgent need.

In addition to the development of a new enlarged trunk distribution system, each of the local municipalities, particularly the larger ones, has undertaken an aggressive program to construct local distribution facilities that will enable them to make use of the new available water.

Various of the existing water production systems assumed by the metropolitan corporation have been integrated into an operating unit, and a high standard of plant operation has been maintained. Staff in-training for employees has been commenced, although the years to come will see a considerable extension of this work. Maintenance forces for high-voltage electrical equipment, trunk mains, water meters, reservoirs, tanks, and associated equipment have been established and are working efficiently.

Table 4 shows extensions that have been made in metropolitan Toronto facilities up to the present.

Future Expansion

Conditions that prevailed at the birth of the metropolitan corporation and those that exist today have been discussed, but this review would not be complete if mention were not made of the plans for further expansion through to 1980, when this water district will have a population close to 2,100,000.

The 1954 report of the consulting engineers stated that eventually a new filtration plant would be required in the western zone. Accordingly, independent consultants were engaged in the latter part of 1956 to report on this matter and to evaluate the work accomplished and to be commenced under the original program in the light of new load factors revealed during 1954, 1955, and 1956.

The consultants subsequently recommended a 22-year program of improvements for the period 1958–80, with suggested construction schedules.

Some of the projects were the same as in the original report.

The engineers have stated that, although the maximum filtration plant capacity required at present is in the vicinity of 360 mgd, by 1980 this figure will have risen to 617 mgd (peak demand). Per capita consumption will rise in the same period, owing to better living standards, from 114 to 137 gpcd.

Two new major water plants, with a total capacity of 300 mgd—one in the east and one in the west—with large enough distribution mains to convey the water into the metropolitan area, are suggested for construction.

Extensive new reservoirs with a capacity of 245 mil gal will be required in the various pressure districts to supply the demands.

Several pumping stations adequate to distribute the water from the two new plants and through comprehensive new mains will also be essential.

An elaborate central operating control for the integration of all plant, pumping station, and reservoir operations was also included in the recommendations.

Although a construction schedule for every future project has been carefully established in the new report, each is subject to some variation—either forward or backward, depending on actual operating conditions, which will be examined and evaluated at least once a year.

Significant factors, which will play an important role in the timing of future projects, are policies that may be adopted on the use of water for lawn sprinkling and air conditioning. The present practice of permitting the use of unlimited amounts of water for air conditioning places a severe demand on the system, and will hasten the time when new filtration plants are required. Conversely, the adoption of a new bylaw presently under study, which would restrict the use of water in air-conditioning units, would delay the necessity for the construction of certain plants and reservoirs for several months, with consequent savings in interest.

Although lawn-sprinkling restrictions will probably not be required during 1959, consideration will have to be given future policy, because moderate restrictions from 1960 on would permit some delay in the commencement date of future water supply projects and a consequently lower water rate structure.

Conclusion

The author has been privileged to visit many of the United States, particularly in the southern region. Many of these, especially in desert regions, are hard pressed to provide sufficient water for their citizens. Toronto is indeed fortunate in its location on Lake Ontario. In order to get water to its citizens, there is no problem that engineering cannot overcome, provided there is sufficient money.

Although Toronto has a seemingly unlimited supply of water, there is no ground for complacency or carelessness in its use. The metropolitan corporation has authorized funds and projects which will provide this area with the most up-to-date and adequate sewage treatment facilities. This program will be undertaken in conjunction with construction of new water supply facilities.

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Honorary Chairmen—Awards

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Honorary Chairmen—Reception

Mr. & Mrs. Paul Weir Mr. & Mrs. F. C. Amsbary Jr. Mr. & Mrs. M. B. Cunningham

Local Committee

R. E. Morris, *Co-Chairman* Earl W. Sudderth, *Co-Chairman*

T. L. Amiss L. C. Eldridge L. A. Jackson J. H. O'Neill
A. R. Davis R. O. Gresham W. S. Mahlie J. R. Pierce
V. M. Ehlers R. W. Harding F. L. McDonald E. R. Stapley
A. H. Ullrich

Potpourri

Henry J. Graeser Jr., *Chairman*

Annual Dinner and Dance

Quintin B. Graves, *Chairman*

K. F. Hoefle R. L. Lawrence L. A. Jackson

Ladies Entertainment Committee

Mrs. Henry J. Graeser, *General Chairman*

Ladies Rendezvous

Mrs. R. B. Allen, *Chairman*

A Pink Tea

Mrs. K. F. Hoefle, *Chairman*

Bluebonnet Luncheon and Style Show

Mrs. W. E. Pebworth, *Chairman*

Tricks and Treats Card Party

Mrs. R. E. Morris, *Chairman*

1958 CONFERENCE STATISTICS

Dallas Registration by Days

Day	Men	Ladies	Total
Sunday, Apr. 20	1,315	450	1,765
Monday, Apr. 21	812	220	1,032
Tuesday, Apr. 22	137	17	154
Wednesday, Apr. 23	61	—	61
Thursday, Apr. 24	12	—	12
TOTALS	2,337	687	3,024

Geographic Distribution of Registrants

UNITED STATES & TERRITORIES					
Alabama	42	Maryland	25	South Dakota	9
Arizona	18	Massachusetts	29	Tennessee	60
Arkansas	79	Michigan	79	Texas	620
California	161	Minnesota	33	Utah	4
Colorado	38	Mississippi	29	Virginia	25
Connecticut	23	Missouri	99	Washington	21
Delaware	11	Montana	9	West Virginia	23
Dist. Columbia	16	Nebraska	20	Wisconsin	78
Florida	43	New Hampshire	2	Wyoming	2
Georgia	48	New Jersey	119		
Hawaii	1	New Mexico	11	**CANADA**	
Illinois	171	New York	184	Brit. Columbia	1
Indiana	94	North Carolina	28	Manitoba	1
Iowa	58	North Dakota	8	Ontario	79
Kansas	65	Ohio	121		
Kentucky	32	Oklahoma	73	**FOREIGN**	
Louisiana	92	Oregon	9	Asia	1
Maine	4	Pennsylvania	168	Europe	8
		Puerto Rico	2	Latin America	9
		Rhode Island	16		
		South Carolina	23	**TOTAL**	3,024

Comparative Registration Totals—1949–1958

Year	Place	Men	Ladies	Total
1958	Dallas	2,337	687	3,024
1957	Atlantic City	2,398	669	3,067
1956	St. Louis	2,026	510	2,536
1955	Chicago	2,075	512	2,587
1954	Seattle	1,536	527	2,063
1953	Grand Rapids	1,532	365	1,897
1952	Kansas City	1,600	386	1,986
1951	Miami	1,415	491	1,906
1950	Philadelphia	1,678	329	2,007
1949	Chicago	1,593	374	1,967

Win, Place & Show in Section Awards

Henshaw Cup		**Hill Cup**		**Old Oaken Bucket**	
Pacific Northwest	**70.6%**	**Iowa**	**30.26**	**California**	**1,424**
Rocky Mountain	64.1%	Rocky Mountain	27.50	Southwest	1,031
Arizona	59.5%	Ky.-Tenn.	19.20	New York	866

Association Awards

Honorary Membership was conferred upon Morrison B. Cunningham, Victor M. Ehlers, Fred G. Gordon, and Louis F. Warrick. The citations follow:

MORRISON BENJAMIN CUNNINGHAM, Director of Public Works, Oklahoma City, Okla.: *Member of the Association since 1930; President 1954; Director for the Southwest Section 1948–51; Fuller Award 1949; a devoted servant of the people of his city; an example of the pioneer spirit of his state; and, above all, a loyal citizen of his country.*

VICTOR MARCUS EHLERS, Director, Division of Sanitary Engineering, Texas State Department of Health: *Member of the Association since 1927; Fuller Award 1941; one who has devoted his life to the health and welfare of the people of his great state; a firm believer in the value of voluntary organization to promote worthy public enterprises.*

FRED GUYON GORDON, Assistant Chief Engineer, Bureau of Engineering, Department of Public Works, Chicago, Ill.: *member of the Association since 1921; Life Member 1951; Director Illinois Section 1951–54; Diven Medal 1956; an engineer thoroughly grounded in the criteria of his profession; one who possesses the ability to evaluate those elements essential to the development of reliable facilities for water supply installations.*

LOUIS FREDERICK WARRICK, Chief, Technical Services Branch, United States Public Health Service, Washington, D.C.: *member of the Association since 1920; Life Member 1950; Fuller Award 1940; long a leader in sanitary engineering; a constructive thinker and advocate of progress in the field of environmental sanitation; one who has for long inspired his associates to worthwhile action.*

The John M. Diven Medal, awarded to the member whose services to the water works field during the preceding year are deemed most outstanding, was presented to Ray L. Derby. The citation follows:

RAY LYLE DERBY: Principal Sanitary Engineer, Department of Water and Power, Los Angeles, Calif.: *for his noteworthy work in the field of control of water quality through the many phases of purification and treatment, and for his efficient leadership in the preparation of the Tenth Edition of* Standard Methods for the Examination of Water, Sewage, and Industrial Wastes.

The John M. Goodell Prize, granted for the best paper published in the JOURNAL from October 1956 through September 1957, was conferred upon Herbert O. Hartung. The citation follows:

HERBERT O. HARTUNG, Vice-President and Manager of Production, St. Louis County Water Company, St. Louis, Mo.: *for his paper entitled "Calcium Carbonate Stabilization of Lime-Softened Water," as published in the December 1956 issue of the Journal* (Vol. 48, page 1523). *Mr. Hartung's paper records an intensive and careful study of certain new aspects of stabilization of water*

which, as time passes, will contribute to the general improvement of the quality of water delivered to the users of municipal supplies.

Division Awards, granted for the best JOURNAL paper (October 1956–September 1957) in the field of interest of each of the four AWWA Divisions, were presented to Jerome B. Wolff, Hyman H. Gerstein, Graham Walton, and Harvey O. Banks. The citations follow:

Distribution Division Award: JEROME BENJAMIN WOLFF, Chief, Bureau of Engineering, Baltimore County Department of Public Works, Towson, Md.: *for his paper entitled "Forecasting Residential Requirements for Distribution Systems." This paper, published in the March 1957 issue of the Journal* (Vol. 49, page 225), *very competently appraises the impact of rapid population growth in American cities and strongly advocates an annual reexamination of the ability of the water system to meet the impending customer demand.*

Management Division Award: HYMAN H. GERSTEIN, Assistant Chief Water Engineer, Department of Water and Sewers, Chicago Ill.: *for his paper entitled "Impact of Water Use for Air Conditioning on Chicago's Water System." This paper, published in the June 1957 issue of the Journal* (Vol. 49, page 697), *is a dramatic account of the heavy burden placed upon the pumping and distribution facilities of the Chicago system, emphasizing the critical need for stronger regulation and conservation of water.*

Purification Division Award: GRAHAM WALTON, Senior Sanitary Engineer, Water Treatment Evaluation Studies, Water Supply and Water Pollution Program, Robert A. Taft Sanitary Engineering Center, United States Public Health Service, Cincinnati, Ohio: *for his paper entitled "Relation of Treatment Methods to Limits for Coliform Organisms in Raw Waters." This paper, published in the October 1956 issue of the Journal* (Vol. 48, page 1281), *clearly appraises the values to be derived from improvements in water treatment methods and points the way to greater water supply.*

Resources Division Award: HARVEY OREN BANKS, Director, State Department of Water Resources, Sacramento, Calif.: *for his paper entitled "Sea Water Intrusion in California." This paper, published in the January 1957 issue of the Journal* (Vol. 49, page 71), *records the information developed from field studies made by the authors and will serve as a guide toward the solution of problems adversely affecting ground water development along the coastlines. (Coauthors of this paper with Mr. Banks were R. C. Richter and James Harder, also of the Department of Resources.)*

The Wendell R. LaDue Safety Awards, granted to utilities for outstanding accomplishment in safety during a calendar year, were presented to the Duluth (Minn.) Water Division and the East Bay Municipal Utility District of Oakland, Calif. The citations follow:

Class 2: DULUTH (Minn.) WATER DIVISION, M. D. Lubratovich, General Manager, Water, Gas, and Sewage Treatment: *for a perfect 1957 safety record*

covering 207,840 man-hours of work by 100 employees. (Joseph R. Tomars is Safety Director.)

Class 3: EAST BAY MUNICIPAL UTILITY DISTRICT (Oakland, Calif.), John W. McFarland, General Manager: *for the best 1957 "Injury Frequency Rate" among utilities of its class—its rate of 2.14 representing only five lost-time injuries among 1,200 employees working 2,341,242 man-hours. During the year, the District established a new national record of 1,402,288 man-hours without a lost-time injury. (Arthur J. Webb is Safety Coordinator.)*

The Harry E. Jordan Scholarship Award, granted to further the education of deserving applicants from the Southeast (a different region is selected each year), was conferred upon James D. Goff, a senior in civil engineering at Southern Methodist University, Dallas, Tex.

The George Warren Fuller Awards were presented to 27 men whose sections had nominated them in the year beginning with the 1957 Annual Conference at Atlantic City and ending with the opening of the 1958 Conference at Dallas. The awards—which are conferred for "distinguished service in the water supply field and in commemoration of the sound engineering skill, the brilliant diplomatic talent, and the constructive leadership of men in the Association which characterized the life of George Warren Fuller"—went to the following men:

Alabama-Mississippi Section—WILLIAM HAYES GILMORE: *for his untiring efforts in working with and helping to train water works operators; for his unselfish devotion to the preparation of a comprehensive water works manual; and for his other valuable contributions to the Section.*

Arizona Section—QUENTIN MICHAEL MEES: *for his outstanding contribution to the education of the operators of water works in the state of Arizona.*

California Section—HARRY REINHARDT: *for his sound technical and administrative ability in the field of water supply; for his skillful guidance of a large California water utility during a period of unprecedented population growth and increasing water demand; and for his many services to the Section.*

Canadian Section—GEORGE HUDSON STRICKLAND: *for his accomplishments in public service; for marked efficiency in the field of water treatment and distribution; and, especially, for the promotion of training facilities for water works operators.*

Chesapeake Section—ALBERT GEORGE FIEDLER: *for distinguished service to the water works industry through his many contributions to the improvement of ground water yields by the application of scientific principles to well construction.*

Florida Section—SIDNEY WILSON WELLS: *as a testimonial to his sterling character; his competence in water treatment; his many years of labor unstintingly given to state water works short schools; and his inestimable value to the water works personnel of the state.*

Illinois Section—DEWEY W. JOHNSON: *for his outstanding services in the promotion of better water works practices; for his untiring efforts in membership promotion; and for his unselfish devotion to the advancement of the Association during his many years of service as secretary-treasurer of the Illinois Section.*

Indiana Section—JACK GORDON: *for his tireless efforts in advancing the Section and the Association; for his conception of the Bradley Award, which has improved attendance materially at district meetings; and for directing the membership campaign which brought the Hill Cup to the Section in 1956.*

Iowa Section—PAUL J. HOUSER: *for his untiring efforts in safeguarding public water supplies and promoting water conservation; for his leadership in conducting regional meetings and schools of instruction; and for his loyal support of the concepts which permeate and stimulate the Iowa Section.*

Kansas Section—PAUL DUNLAP HANEY: *for distinguished service to Kansas communities; for outstanding achievement in affairs of the Association and the Section; for contributions to water purification and treatment practice; and for constant loyalty to the highest ideals of the water works profession.*

Kentucky-Tennessee Section—CHARLES HERMAN BAGWELL: *for his faithful and loyal service to the Section and, in particular, for his diligent efforts in obtaining favorable legislation in Tennessee toward reimbursement of water utilities for expenditures for relocation of installations necessitated by federal-aid highway construction.*

Michigan Section—HARRISON HENRY CASWELL: *in recognition of his nearly three decades of efficient and successful operation of his community's water system; for his services as trustee, chairman, and national director, as well as his many other valuable contributions to the Michigan Section.*

Missouri Section—GARVIN HENRY DYER: *in tribute to his many years of unselfish service to the water works industry and to the Section as a member, committee chairman, and officer, and in special recognition of the credit reflected upon our profession throught the honors bestowed upon him by his fellow professional engineers.*

Montana Section—CLAIBORNE WILLIAM BRINCK: *for his leadership in promoting public health engineering in Montana; his interest in promoting superior water supplies for Montana cities and towns; his leadership in promoting the annual Montana Water Works School and the affairs of the Montana Section.*

Nebraska Section—JOHN WILLIAM KRUSE (deceased): *for his tireless efforts in behalf of the Section, particularly as secretary of the utilities section of the League of Nebraska Municipalities, in which position he effectively and unselfishly promoted understanding, cooperation, and progress in the water works industry.*

New England Section—JOSEPH CARLETON KNOX: *for his untiring efforts and successful accomplishments in promoting the organizations of officials and professional workers in the water works and water conservation fields and in fur-*

thering the advancement of water supply and conservation programs for the good of New England and surrounding areas.

New Jersey Section—WILLIAM JOHN ORCHARD: *for his many services to the Association, especially his efforts in founding the New Jersey Section; his untiring work toward resolving the water supply problems of New Jersey; and his encouragement of important advances in the technology of water treatment.*

New York Section—LEWIS BRUTON SMITH: *for his distinguished service as head of the Rochester water utility during a period of rehabilitation and development when the sources of supply were inadequate; and for his services as trustee and chairman of the Section.*

North Carolina Section—EARLE COLVIN HUBBARD: *for his energetic devotion to the advancement of the Section, particularly as secretary-treasurer; his untiring efforts with and for the operators' group; and his years of faithful public health engineering activities in improvement of public water supplies.*

North Central Section—GEORGE JOHN SCHROEPFER: *for the long years of continuous leadership in his profession, deep interest in the water works school, and his inspiring efforts in behalf of young men interested in the water works field and the Association.*

Ohio Section—RAYMOND HAROLD FULLER: *for his outstanding services on water resources studies and problems in Ohio; for his sound engineering ability, and for his long and continuing work on important committees and affairs of the Ohio Section.*

Pennsylvania Section—WILLARD FREDERICK ROCKWELL: *in recognition of the eminent distinction which he has achieved in the field of industrial development and the service he has rendered to his government in peace and war, as well as to the water works profession and to this Association.*

Southeastern Section—LEWIS RAY SIMONTON: *for his many years of progressive leadership in water supply in his city, state, and the Southeastern Section; for his devotion to duty, tireless efforts, and conscientious endeavors in the upgrading of our profession, which have been an inspiration to all who know him.*

Southwest Section—GEORGE HARRISON WEST: *for his long and efficient service in the water supply field; productive efforts in promotion of education of water department personnel through in-service training; and contributions as secretary of the Louisiana Conference on Water Supply and Sewerage.*

Virginia Section—HARRY NICHOLAS LOWE JR.: *for his outstanding contributions to the Virginia Section, the Association, and the water works profession in papers covering development of water treatment methods and equipment for the US Army Corps of Engineers.*

West Virginia Section—THOMAS JACKSON BLAIR JR.: *for his many years of service to the public through his competent management of water utilities; for his encouragement and training of young men to advance the water supply industry; and for his many services to the section and the Association.*

Wisconsin Section—M. STARR NICHOLS: *in recognition of his many services to the Section and the state, particularly through committee work, training courses, and contributions to Section meeting programs; his studies of fluoride content of water supplies; and his continuing interest in research and water works problems.*

Schedule of Conference Papers and Reports

MONDAY MORNING, Apr. 21

General Session

A HiddenWorld—Motion Picture.....Allis Chalmers Mfg. Co.
Water Supply Advancement—Presidential Address.....Fred Merryfield
AWWA's Public Information Program.....John H. Murdoch Jr.
Discussion.....J. F. O'Grady & Richard V. Ford
AWWA Policy on Recreational Use of Water Storage Reservoirs.....Wendell R. LaDue
AWWA Standards—Shall They Be Enforced?.....Louis R. Howson

MONDAY AFTERNOON, Apr. 21

Water Resources Division

Lifeblood of the Land—Motion Picture.....US Dept. of Agriculture
Research in Evaporation Reduction.....Uel Stephens
Operation of the Arkansas-White-Red Basins Interagency Committee.....John A. Short
Water Quality Studies in the Arkansas–Red River Basin.....Keith S. Krause
Discussion.....Dwight F. Metzler
Water Works Experiences With the Missouri River Basin Control System...M. P. Hatcher
Discussion.....Joe K. Neel, Joseph F. Erdei & H. O. Hartung
The Impact of Recreation on the Lower Colorado River.....Robert K. Coote

Water Works Administration Committee—Open Session

Radio and Mobile Communications.....M. B. Cunningham
Safety Practices.....R. J. Faust
Education.....R. J. Faust
Joint Administration of Water and Sewer Facilities.....L. N. Thompson & R. J. McLeod
Water Use.....H. E. Hudson Jr.
Job Classification.....R. S. Millar
Rating Scale for Water Works.....John H. Murdoch Jr.

TUESDAY MORNING, Apr. 22

Water Resources and Water Works Management Divisions—Joint Session

Corralling the Colorado—Motion Picture.....US Dept. of Interior
Ontario's Water Resources Law.....A. E. Berry
Discussion.....C. G. R. Armstrong
Regional Water Supplies—Financing and Cost Allocation.....Richard Hazen
Watershed Development Plans for the Sabine River.....John W. Simmons
Texas Water Problems.....Marvin C. Nichols & T. C. Forrest Jr.

Water Distribution Division

Water From Plans to Plenty—Motion Picture.....Indianapolis Water Co.
The Value of Cathodic Protection.....George B. McComb

A New Stray-Current Problem.....Hugh L. Hamilton
Operating Southern California's Colorado River Aqueduct System.....Robert B. Diemer
Plastic Coating and Lining for Steel Pipe.....G. E. Burnett & C. E. Selander

TUESDAY AFTERNOON, Apr. 22

Water Works Management and Water Distribution Divisions—Joint Session

Operation Noah—Motion Picture.....US Corps of Engineers
Making Street Construction Acceptable to the Public.....Burton S. Grant
The Part Played by Water in Modern Fire Control.....M. M. Braidech
Problems in Locating Elevated Tanks.....Clyde E. Williams
Alternate Sources of Power for Water Works Pumping Stations.....Edward Farmer
Emergency Organization to Control Water Main Breaks.....
Paul Weir, Samuel S. Baxter, Frank E. Dolson & H. W. Niemeyer

Water Purification Division

Value and Limitations of Chlorine Residuals in Distribution Systems—Panel Discussion.....
Led by H. A. Faber,
John R. Baylis, M. P. Crabill, A. E. Griffin & E. J. Umbenhauer
Monitoring Stream Water Quality—Panel Discussion.....*Led by* H. O. Hartung,
Edward J. Cleary, Ralph Palange & Lee Streicher
The Emergency Reuse of Water at Chanute, Kansas:
Part 1.....Dwight F. Metzler, Russell L. Culp & H. A. Stoltenberg
Part 2.....Richard L. Woodward, S. L. Chang,
N. A. Clarke, F. M. Middleton, C. M. Palmer & Graham Walton
Discussion.....C. H. Connell

WEDNESDAY MORNING, Apr. 23

Water Purification Division

Mountain Water—Motion Picture.....US Dept. of Agriculture
Effect of Synthetic Detergents Upon Water Softening Economics.....
W. W. Aultman & T. E. Larson
Chemistry of Chlorine Dioxide.....M. L. Granstrom
Electrophoretic Studies of Water Coagulation.....Janet B. Pilipovich,
A. P. Black, T. W. Stearns & F. A. Eidsness
Use of Hydraulically Backwashed Screens for Surface Water.....Ernest W. Whitlock &
Robert D. Mitchell

Water Works Management Division

Safety in Construction, Plant, and Office.....
Arthur J. Webb, James E. Hickman & Thomas Allen
Work Simplification for Water Works.....W. S. Deniger
Handling Customers and Employees.....Victor A. Appleyard & Kenneth E. Shull
Organizing the Team.....Paul Weir

WEDNESDAY AFTERNOON, Apr. 23

Water Resources Division—General Session

Water for Everyone—Motion Picture.....Steel Plate Fabricators Assn.
Task Group Report—Ground Water Recharge.....J. J. Baffa
Ground Water Reservoirs as Hydrologic Systems.....J. G. Ferris

Recent Legislation Concerning Water Rights—Panel Discussion.....*Led by* H. E. Jordan, C. H. Bechert, John W. Cramer, A. R. Davis, H. C. Barksdale, Roy W. Morse & Lynn M. Miller
Whither Water Law.....Abel Wolman

THURSDAY MORNING, Apr. 24

Joint Session With Inter-American Association of Sanitary Engineering

Engineering Your Health—Motion Picture.....US Public Health Service
A Review of Water and Sewage Sanitary Engineering Research.....H. A. Faber & Bernard B. Berger
Report of Water Works Facilities and Construction Throughout the World..Fred Merryfield
Development and Operation of Municipal Water Systems in Mexico.....Clicero Villafuerte & Pedro J. Caballero
Sanitary Engineering Educational Programs and Philosophies in Latin America Daniel A. Okun

Management and Distribution Division Workshop

Research on Reduction of Water Main Capacity.....T. E. Larson
Research on Developing Protective Coatings for Water Mains.....R. F. McCauley
A Study of Domestic Water Use.....H. E. Hudson Jr.
Meter Records: the Basis for System Planning.....Henry J. Graeser, R. B. Raw & A. R. Davis

THURSDAY AFTERNOON, Apr. 24

Water Purification Division Workshop

Manganese Problems.....A. E. Griffin
Manganese Research.....Floyd I. Brownley Jr.
Iron and Manganese Reduction.....E. J. Taggart & V. J. Calise
Planned Research on Filter Washing.....W. W. Aultman
Some Studies on Filter Washing.....Raymond E. Hebert & John R. Baylis
Membrane Filters—Task Group Report.....R. L. Woodward & Ray L. Derby
Analytical Methods for Detergents.....James C. Vaughn
Chlorine Standards and Research.....L. L. Hedgepeth
Water-Conditioning Devices.....Rolf Eliassen, Rolf T. Skrinde & W. B. Davis

Water Works Practice Committee—Open Session

Selection of Protective Coatings for Valves and Hydrants.....Loring E. Tabor
Efficient Fire Hydrants.....Gerard A. Wyss & W. J. Burns
Standards for Construction and Painting of Elevated Tanks.....J. O. Jackson
Oil-Line River Crossings.....M. B. Cunningham
Steel Pipe Manual.....H. A. Price

Social Calendar

Sunday	1:00 PM	Exhibit Open House	Convention Hall, Auditorium
	6:00 PM	The Big "D" Buffet	Crystal Ballroom, Baker Hotel
Monday	2:00 PM	A Pink Tea	Peacock Terrace, Baker Hotel
	8:00 PM	Awards and President's Reception	Crystal Ballroom, Baker Hotel

Tuesday	8:30 AM		
	1:00 PM	Annual Golf Tournament	Preston Hollow Country Club
	12:00 Noon	Bluebonnet Luncheon and Style Show	Grand Ballroom, Statler Hiltor Hotel
	8:30 PM	Potpourri	Lyceum Theatre, Auditorium
Wednesday	2:00 PM	Tricks and Treats Card Party	Ladies Rendezvous, Auditorium
	Evening	No scheduled entertainment	
Thursday	6:45 PM	Annual Dinner and Dance	Grand Ballrom, Statler Hilton Hotel

Exhibitors

Adams Pipe Repair Products
American Cast Iron Pipe Co.
American City Magazine
AWWA Public Information Program
AWWA Safety Campaign
American Well Works
Armco Drainage & Metal Products, Inc.
Badger Meter Mfg. Co.
Baker & Co., Inc., R. H.
Barrett Div., Allied Chemical & Dye Corp.
B-I-F Industries, Inc.
Brainard, F. S., & Co.
Brooks Products, Inc.
Buffalo Meter Co.
Burgess-Manning Co., Penn Instruments Div.
Byron Jackson Pumps, Inc.
Centriline Corp.
Chicago Bridge & Iron Co.
Cla-Val Co.
Clow & Sons, Inc., James B.
Darling Valve & Mfg. Co.
DeLaval Steam Turbine Co.
DeZurik Corp.
Dorr-Oliver Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Engineering News-Record
Everson Mfg. Co.
Filtration Equipment Corp.
Fischer & Porter Co.
Fisher Research Lab., Inc.
Flexible, Inc.
Ford Meter Box Co., Inc.
Foster Engineering Co.
Foxboro Co.
Gamon Meter Div., Worthington Corp.
General Filter Co.
Gifford-Hill-American, Inc.
Glenfield & Kennedy, Inc.
Golden-Anderson Valve Specialty Co.
Graver Tank & Mfg. Co., Inc.
Hach Chemical Co.
Hagan Chemicals & Controls, Inc.
Hammarlund Mfg. Co., Inc.
Hanks Co., Fred W.
Harco Corp.
Hays Mfg. Co.
Hersey Mfg. Co.
Industrial Chemical Sales Div., West Virginia Pulp & Paper Co.
Inertol Co., Inc.
Infilco Inc.
International Salt Co.
Johns-Manville
Keasbey & Mattison Co.
Kennedy Valve Mfg. Co.
Koppers Co., Inc., Tar Products Div.
Layne & Bowler, Inc.
Leopold Co., Inc., F. B.
Link-Belt Co.
Lock Joint Pipe Co.
Lone Star Steel Co.
Ludlow Valve Mfg. Co., Inc.
McDonald Mfg. Co., A. Y.
McWane Cast Iron Pipe Co.
M&H Valve & Fittings Co.
M-C-G Co., Inc.
Minneapolis-Honeywell Regulator Co.
Mueller Co.
National Water Main Cleaning Co.
Neptune Meter Co.
Permutit Co., Div. of Pfaudler-Permutit, Inc.
Pipe Linings, Inc.
Pitometer Associates, Inc.
Pittsburgh-Des Moines Steel Co.
Pratt Co., Henry
Preload Co., Inc.
Price Brothers Co.
Public Works Magazine
Roberts Filter Mfg. Co.
Rockwell Mfg. Co.
Ross Valve Mfg. Co., Inc.
Sherman Products, Inc.
Simplex Valve & Meter Co.
Smith Mfg. Co., A. P.
Smith-Blair, Inc.
Smith Co., S. Morgan
Sparling Meter Co.
Stuart Corp.
Trinity Valley Iron & Steel Co.
Tyler Pipe & Foundry Co.
United Concrete Pipe Corp.
United States Pipe & Foundry Co.
Vogt Mfg. Co.
Wachs Co., E. H.
Walker Process Equipment, Inc.
Wallace & Tiernan Inc.
Water & Sewage Works
Water Tank Service Co.
Water Works Engineering
Well Machinery & Supply Div., Worthington Corp.
Welsbach Corp., Kitson Valve Div.
Wheeler Mfg. Co., C. H., Economy Pump Div.
Wood, R. D., Co.

Papers Scheduled at 1958 Section Meetings

THERE follows a summary listing of papers scheduled for presentation at 1958 Section Meetings. The dates of the Section Meetings from 1954 to 1958 and the locations for 1958 are listed on page 1650. Section officers who were elected at meetings held during 1958 are listed on page 2 P&R in the front of this issue. The programs are listed alphabetically by Sections, without regard to the date of presentation.

Alabama-Mississippi Section—Sep. 28–Oct. 1, 1958

Address of Welcome.....*Mayor* Laz Quave
The AWWA Water Works Advancement Program.....Lewis S. Finch
The Responsibilities and Duties of Water Works Management.....Tip H. Allen
Management of Utility Revenues.....W. L. Gilmer
Extension Policies, Connection Charges, and Fire Service Charges—Panel Discussion
Tom H. Collins, Lewellyn Dean, W. U. Quinby & E. M. Stickney
Safety in Water Works Operation.....Fred Scott Jr.
Public Relations in Water Works Operations.....Warren Whitney
Preventative Maintenance Program for Wells and Pumps.....John L. Snow
Insurance Plan for Water Utilities.....C. Shaw
Water Works Management.....A. E. Gatlain
Rate Making in Publicly Owned Water Systems.....James E. Jagger
Value of Reports and Budgets to Management of Water Works Operation...J. S. Parrish
Solving the Problems of Unaccounted-for Water.....Jess L. Haley
Filmstrip:
The Story of Water Supply

Arizona Section—May 15–17, 1958

Address of Welcome.....*Mayor* Don Hummel
Response.....Quentin Mees
Monitoring Streams for Radioactive Contamination.....W. B. Schreeder
Manhole Brick, Laying Methods, and Specifications.....Archie Campbell
Installation of PVC Plastic Tubing for Water Mains and Services.....
Carl A. Johnson & James M. Hennessy
A New Method for Laying Sewers.....Rod T. Antrim
Corrosion of Concrete and Steel Under Sewage Conditions.....C. G. Munger
Supervisory Control as Applied to Water Systems.....George W. Barr
Tucson's Water and Sewage Disposal Expansion Program.....Porter W. Homer
Solving Industrial Waste Water Disposal Problems.....C. F. Garland
A New Perspective for Sewerage Systems.....Kenneth Scharman
Specifications and Contracts: The Owner, the Engineer, the Contractor, and the Manufacturer.....Dave Harmon
Hydrants, Mains, and Growing Pains.....Frank C. Jones
Recreational Use of Water Reservoirs.....Ray L. Derby
Basis of Rate Making for Private Water Companies.....William H. Howe
Financing Capital Improvements for Private Water Companies.....G. Ted Rekerdre

California Section—Oct. 28–31, 1958

Address of Welcome.....John S. Gibson Jr. & J. C. Moller Jr.
Response.....Duncan A. Blackburn
State Department of Water Resources.....Harvey O. Banks
Metropolitan Water District of Southern California.....Robert B. Diemer
Los Angeles Department of Water and Power.....Burton S. Grant
City of San Diego.....Paul Beermann
East Bay Municipal Utility District.....Joseph D. DeCosta
City of Santa Cruz.....Weston L. Webber
Problems of Water Main Extensions to Fringe Areas.....William R. Seeger
Separation of the Water Utility From the General City Government.....John Fee
The Importance of Good Public Relations and Publicity in Utility Operations
J. W. McFarland
Utilization of Fire Hydrants for Bacteriological Sample Points.....Gordon Ehrhardt
Diatomaceous Earth Filters in Municipal Water Treatment.....Everett Ross
The Public Health Significance of Waste Water Reclamation.....J. A. Harmon
Water Reclamation and Recharging of Underground Basin and Aquifers in the Santa Clara Valley.....J. Robert Roll
Dead-End Flushing Program.....Harry Hayes
Telemetering and Automation as Applied to Water Utilities.....John L. Mapes
A Fifth Freedom.....R. F. Sentner
Use of Asphalt in Water Utilities.....Carl F. Lind
Recent Legislation on Use of Reservoirs and the Effect on Treatment Requirements for Surface Waters.....Edward A. Reinke
Safeguarding Water Systems in Unstable Areas.....Emil S. Mamrelli
Radio Communication for Water Utilities.....Lee B. Hertzberg
Mechanical Insulators to Reduce Corrosion.....Robert R. Ashline
Watershed Management Research.....James Patric
Organizing a Master Disaster Plan.....Jeptha A. Wade Jr.
Safety Practices
Progress in Safety in the California Section.....Chandler A. Laughlin
Experiences in Reducing Injuries in Water Utilities.....Harold E. Butler
What Kind of a Guy Are You?.....Louis Hackemann
Penny-Wise Water.....Lewis S. Finch

Canadian Section—Jun. 2–4, 1958

Water Supply Problems of the Future—Discussion.....*Led by* W. R. Godfrey
Suburbia Explodes.....Frederick G. Gardiner
Distribution of Water in Metropolitan Toronto.....R. L. Clark
Improved Pretreatment Methods in Water Filtration.....W. G. McKay
Automation in Water Works—How Far Should It Go?
From the Standpoint of the Designer.....Harry Grunwell
From the Standpoint of the Operator.....G. H. Strickland
Growth and Financing Problems in Water Works—Discussion.....*Led by* J. D. Kline
Ground Water Problems and Recharging Operations.....A. K. Watt
Aquatic Organisms and Vegetation in Water.....R. Thompson & J. H. Neil

Canadian Section—Maritime Branch—Oct. 2–3, 1958

Problems in Water Works Operation—Discussion.....*Led by* W. L. Barrett
Polythene Pipe for Municipal Water Services.....Ralph A. Noble
Sewage and Sanitation Problems—Discussion.....*Led by* M. H. Rogers
A New Method of Fine Straining for Water Supplies.....G. R. Evans
Management & Office Procedures—Discussion.....*Led by* H. A. March

New Brunswick Water Resources & Pollution Control Board.....John S. Bates
Advancement of the Water Works Industry.....James B. Corey
The Question Box—Discussion.....*Led by* A. F. Wigglesworth

Chesapeake Section—Oct. 29–31, 1958

Address of Welcome.....*Mayor* Eugene Lammot
Operation of the Ion Exchange Process at High Flow Rates.....A. W. Fynsk
Safety in Water Works.....John W. Krasauskas
Beach Area Water Supplies.....Turbit Slaughter
Utilities Relocation and Highway Projects.....John B. Funk
Economic Poisons' Effects on Water Supplies.....George W. Burke
Susquehanna Water Supply Projects for Metropolitan Baltimore.....Bernard L. Werner
AWWA Comes of Age.....Harry E. Jordan
Delaware's Interest in the Delaware River Basin.....Richard A. Haber
Evaluation of Diatomite Filters for the Production of Drinking Water
Harry N. Lowe & Richard Paul Schmitt
Slow to Rapid Sand Filter Conversion.....Miriam S. Shane
Legislative Proposals to Change Eastern Water Law.....Murray Stein

Florida Section—Oct. 19–22, 1958

Address of Welcome.....*Mayors* Sasso, Diefenbach & Milander & Charles Hall
Response.....J. J. R. Bristow & Harold D. Overheiser
Accentuate the Positive—Panel Discussion.....*Led by* Fred A. Eidsness,
Sid Johnston, Charles R. Fischer & Edmond McMorrough
Job Classifications and Salary Scales for Water and Sewage Plant Operators.....
L. J. Turvaville
Advancement of Water Works Industry.....James B. Corey
Needed Legislation for the Water Conservation Program.....John W. Wakefield
Mechanical Packing for the Water and Sewage Plants.....Charles A. Beggs
Polyelectrolytes in Water Treatment.....A. P. Black
Water Supply and Water Pollution Control Research Abroad.....Harry A. Faber
The Development of Certification and Training Programs for Water and Sewage Plant Operation Personnel.....Meredith H. Thompson
Recent Developments in the Treatment of Water and Sewage.....George E. Symons
A Rational Approach to Sampling Programs for Water and Sewage Plants..F. W. Gilcreas

Illinois Section—Mar. 26–28, 1958

Address of Welcome.....James W. Jardine
Water Resources Use.....William C. Ackermann
Spend What You Earn.....H. S. Merz
Relocation and Adjustment of Utilities.....William M. Dutelle
Automatic Lawn-Sprinkling Problems—Panel Discussion.....
E. R. Healy, Armon Lund & Otto S. Hallden
Operating Experience with Hinsdale's Sludge Blanket Water Softening Plant..L. M. Carlman
Discussion.....G. L. Davis
Experiments with Diatomite Filtration of Lime–Soda Softened Water....Robert Enzweiler
Taste and Odor Experiences in Illinois in Comparison With Other States....E. A. Sigworth
Morphology and Classification of Iron Bacteria.....Ralph S. Wolfe
Creative Thinking.....Robert G. Seymour
Plans and Progress of the Elmhurst-Villa Park-Lombard Water Commission.....
Robert T. Palmer
Financing Water Works in 1958.....Carl Chatters
Check Valves: Installation, Maintenance, and Control.....Harry D. Harmon
Natural Radium Content of Illinois Public Water Supplies....A. F. Stehney & H. F. Lucas

Studies of Radioactivity in the Chicago Water Supply.....
James C. Vaughn, Robert Schmid, Alfred Tenny & Arthur Shor
State Agency Programs in Radioactivity Measurement.....
Robert R. French & Laurel M. Henley
Availability of Fluoridation Chemicals—Panel Discussion.....
Max Metziger, Oscar Gullans & H. W. Poston
Motion Picture:
Deep Waters

Indiana Section—Feb. 5–7, 1958

Address of Welcome.....*Mayor* Phillip L. Bayt
Response.....Ray G. Rinehart
Early Water Works Developments in Indiana.....Louis R. Howson
Early Water Works Patents and Inventions.....John L. Ford
Early History of Indiana Water Works Association..... Harry E. Jordan
Water Works Problems Resulting from Annexation of Outlying Areas, Including Planning for Expansion—Panel Discussion.....*Led by* M. P. Susanke,
Ted Schulenberg, Paul W. Phillips, J. B. Wilson,
Max A. Stearns & George G. Fassnacht
The Private Utility Concept of Operating a Municipally Owned Water Utility..A. P. Kuranz
Treatment Plant Innovations at St. Louis County Water Co.....H. O. Hartung
Interrelation of Ground and Surface Waters as Shown by a Study of Hydrologic Data at Lafayette, Ind.....Joseph S. Rosenshein
A Chlorine Residual Study in a Water Treatment System.....
H. L. Plowman Jr. & John M. Rademacher
Where Now?.....Fred Merryfield
Preparation for Rate Increase and Municipal Bond Issue Hearings.....*Led by* W. V. Weir,
G. G. Skelton, C. E. Williams, David N. Brewer,
Cecil M. Fritz & Thomas W. Moses

Intermountain Section—Nov. 6–7, 1958

Address of Welcome.....*Mayor* Adiel F. Stewart
Requirements for Certification of Water Supplies.....Vaughn Anderson
Determination of Water Rates.....W. Franklin Richards
Ground Water Supplies.....John A. Ward
Water Works Accounting and Records.....Ken Price
Electrolysis and Corrosion in Water Systems.....G. H. Garrett
Watershed Use—Panel Discussion.....*Led by* H. F. Kretchman,
F. C. Koziol, Richard C. Nelson, Alonzo F. Hopkin,
Gus P. Backman & E. J. Fieldsted
Public Relations as Applied to the Water Supply Industry.....Jennings Phillips
Maintenance and Operation of Chlorinators and Safe Handling of Chlorine
Richard Sherwood
Safety as Applied to Water Works Operation.....T. L. Hutchings
Filmstrip:
The Story of Water Supply
Television Film:
"Do It Now" Program

Iowa Section—Oct. 15–17, 1958

Address of Welcome.....*Mayor* Charles L. Iles
Water Works Management.....L. W. Grayson
Development and Application of Submersible Pumps in Europe.....K. H. Dean
Cathodic Protection for Hydraulic Structures.....J. L. Rohwedder

Vinyl Paints for Underwater Metal Surfaces.....F. W. Shanks
A Utility Commission for Iowa Water Works?
E. E. Bjork, J. W. Anderson & Glen V. Yarger
Plastic Pipe in Water Works Service.....M. E. Flentje
Water Supply Program of the US Public Health Service.....G. E. McCallum
Certification Program for Water Works Operators.....Marcus P. Powell
Legislation Affecting Water Works Operations.....W. E. Bjork
Safety in Water Works.....J. R. Maloney
Tools of Safety.....A. W. Gaines
Experiences With Water Rights Law.....M. K. Tenny & George S. Lee
Survey of Water Rates, Main Extensions, and Job Classifications
Short Course for Water Works Personnel.....Marcus P. Powell
Regional Water Works Meetings.....P. J. Houser
Board of Directors Meeting, AWWA.....M. K. Tenny
Membership in Iowa Section.....R. H. Thompson
Resolutions of Iowa Section.....Kenneth Ruby
Distribution System Operations—Discussion.....*Led by* John W. Pray & X. P. Boyles
Laboratory Operations—Discussion.....*Led by* R. L. Morris & A. L. Bennett

Kansas Section—Mar. 12–14, 1958

Improvements to Water Quality in Kansas.....Dwight F. Metzler
Financial Problems of Municipal Utilities.....Albert P. Learned
Radioactive Fallout.....Lloyd R. Setter & J. Lee Mayes
The Human Factors in Safety Foremanship.....T. F. McCrary
Discussion of AWWA Safety Program.....O. G. Curan
Address of Welcome.....*Mayor* Ralph F. Exline
Response.....Roy Bluejacket
AWWA Public Information Program.....Raymond J. Faust
The Role of Algae in Water Supplies and Sewage Treatment.....Joe K. Neel
Chlorinators, Troubles, and Trouble Shooting.....Dwane Eller
Probable Accuracy for Proportional Pacing Systems.....Frank Russo
Plant Entrepreneurs—Panel Discussion.....*Led by* Howard Stoltenberg,
B. H. Van Blarcum, Roy Hutchins, R. W. Fassnacht, C. N. Harper,
A. W. Rumsey & Bernard Budd
Tablet Form and Other Chlorination Equipment for the Smaller Installations..Ram Trammell
Find the Pipe, Find the Valve, Find the Leak.....Norvell E. Ireland

Kentucky-Tennessee Section—Sep. 22–24, 1958

Address of Welcome.....*Mayor* Edmund Orgill
Response.....E. E. Jacobson
Operation Bootstrap.....Lewis S. Finch
Challenges Facing a Mature Federation.....K. S. Watson
Water Resources and Water Policy.....Harold V. Miller
Details of Design Which Pay Off in Improved Operation of Water, Sewage and Industrial
Waste Facilities—Panel Discussion.....*Led by* J. Wiley Finney Jr.,
Philip Bell Jr., Herman Regan, W. J. Bricker,
R. M. Gresham & W. L. Ferris
Design and Operation of Chemical Distribution Systems.....V. W. Langworthy
Discussion.....H. C. Wolfenbarger
Water Problems in Freezing Weather.....E. D. Hawkins
Discussion.....John Burka
Operation and Maintenance of Water Works Facilities at Cleveland, Tennessee
Ellis L. Spencer
Discussion.....James I. Finney

Slip-on Type Cast-Iron Pipe Joints.....Harry M. Lange
Discussion.....W. S. Cifers
Operation of Water, Sewage, and Industrial Waste Works—Discussion
Led by Willis H. Lewis, J. W. McCoy, A. L. Strub
R. L. Cross & J. K. Sullins
Motion Picture:
We Have Come a Long Way

Michigan Section—Sep. 8–10, 1958

Address of Welcome.....*Mayor* Stanley J. Davis
Response.....Robert E. Hansen
News from the Field.....John E. Vogt
Financing Water Works.....Louis E. Ayres
Supervisory Controls in Water Works Operation.....
Kenneth H. Abrahamson, Spencer Ferris & Vernon L. Hinebrook
Ground Water Study in Jackson.....Joseph M. Rogeven & William G. Keck
The Design and Development of Ground Water Supplies for Small Communities.....
Edward M. Burt
Behavior of Filter Media.....Jack Borchardt
A Progress Report on the Lake Michigan Short Filter Run Study.....
Merrill B. Gamet & John M. Rademacher
The Design and Operation of the Holland Filtration Plant
Thomas B. Robinson & James Hornung
Thirteen Years of Experience in Fluoridation at Grand Rapids.....F. A. Arnold Jr.
Operation Bootstrap.....Lewis S. Finch
Development and Design of Filtration Plants for Small Communities
Bridgman.....T. C. Williams
East Tawas.....Clifford Spicer
Cathodic Protection of Water Storage Reservoirs.....Albert Sabo
Filmstrip:
The Story of Water Supply

Missouri Section—Sep. 28–30, 1958

Address of Welcome.....*Governor* James T. Blair Jr.
New Wage Law of Missouri.....June R. Rose
Pertinent Aspect Water Pollution Law.....Jack K. Smith
Fundamentals and Methods of Setting Water Meters.....Norvel E. Ireland
Membrane Filter Technique—Panel Discussion.....*Led by* Paul Haney
Water Plant.....Lee Groseclose
Water Plant.....William H. Morley
Division of Health of Missouri.....Irma Adams
Highlights from Leaders of Water Works Industries—Discussion....*Led by* G. E. Boulton
Experiences in Iran.....Major C. Hagar
Effect of Radioactive Fallout on Surface Water Supplies.....Henry J. Rechen
Recreational Use of Municipal Water Supply Reservoirs.....Kirt T. Mosely
A Free Life Insurance Policy.....Charles H. Franklin
A Study of Improved Water Works Methods.....Lawrence C. Day & Carl F. Buettner
Fringe Benefits for Personnel of Water Works Industry in Missouri.....L. J. Lukrofka
Motion Pictures:
Deep Waters
We Have Come a Long Way
Lifeblood of the Land
Living With Radiation

Montana Section—Mar. 20–22, 1958

Address of Welcome.....*Mayor* Alan T. Bradley
Response.....R. G. Cronin & Claude Eyer
Multiple Use of Domestic Water Supply Watersheds.....W. E. Bullard
Public Information.....Fred Merryfield
Municipal Bonding.....Stanton Aby
Round Table Discussion.....*Led by* Carl King
Pollution Abatement—Symposium.....*Led by* Claude W. Eyer, C. W. Brinck, John C. Spindler & John B. Hazen
Motion Pictures:
Lifeblood of the Land
We Have Come a Long Way

Nebraska Section—Apr. 16–18, 1958

Address of Welcome.....*Mayor* Bennett Martin
Response.....R. W. Andrews, George H. H. Beard
Outstanding Municipal Utility Operations.....Karl M. Joens
Public Information and Good Management.....Fred Merryfield
Modern Practices in Water Main Rehabilitation.....J. A. Frank
Atomic Energy.....James L. Grahl
Explanation of L. B. 118 and L. B. 123.....Lowell W. Edwards
Aerial Photography.....George Miller
Sizing Water Meters in Commercial and Industrial Installations.....C. L. Eberly
Status of Underground Water in Nebraska.....Vincent Dreezen
Motion Picture:
Service for Centuries

New Jersey Section—Oct. 23–25, 1958

Building the Ideal Plant.....Romeo A. Falciani
Report of Radiation Committee.....*Led by* Charles G. Bourgin, Robert J. Budrick, Frank J. DeHooge, John J. Hamilton & Peter E. Pallo
Forty-Seven Years With Venturi.....David J. Purdi
Plastic Pipe for Water Works.....Bert S. Montell
Experiences in Operating in the Snowstorm in South Jersey in the Spring of 1958 Benjamin I. Corson, Carl O. Carlson Sr., August C. Schultes, Valdemar E. Edwards Jr. & Gordon L. Walton
In-Training Program of the Philadelphia Suburban Water Co.....Kenneth E. Shull
Water Works Advancement.....James B. Corey
Safety Awards and How Obtained.....Gordon L. E. Linn
New Policies Being Formulated for the Regulation of Water Resources in the State of New Jersey.....George R. Shanklin, Alfred H. Fletcher & Robert S. Shaw
Forty Rules for Preventive Maintenance of Centrifugal Pumps.....David L. Gallagher
Motion Pictures:
Pure Water and Public Health
Pipelines to the Future

New York Section—Mar. 26–28, 1958

Experiences in the Use of Federal Civil Defense Administration Stockpiled Emergency Water Supply Equipment.....R. O. Schindler & Harry F. Edinger
Pipe Joints.....George E. Symons
What Can Be Found Under the Pavements in Schenectady.....Richard E. Weber

A Water Works Manager's Job.....John H. Murdoch Jr.
Application of Centrifugal Water Works Pumps.....C. R. McFarland
Development of AWWA Public Information Program.....Lewis S. Finch
Round Table Discussion.....*Led by* Donald E. Stearns

New York Section—Sep. 10–12, 1958

Financing Water Works Projects.....Frances Stone
Inadequate Water Rates—Symptoms and Treatment.....John H. Murdoch Jr.
The Control of Taste and Odor Problems in New York State as Compared With Overall United States.....E. A. Sigworth
Operations of the Westbury Water District.....Leroy Ebright
Report on AWWA Activities.....John G. Copley
Round Table Discussion.....*Led by* Donald E. Stearns

North Carolina Section—Nov. 10–12, 1958

Address of Welcome.....*Mayor* George H. Roach
Financing of Greensboro's Expanding Utilities.....T. Z. Osborne
Advancement of the Water Works Industry.....James B. Corey
Automation in Water and Sewage Works
From the Standpoint of the Designer.....W. M. Piatt III
From the Standpoint of the Operator.....W. G. Brown
New Developments in Taste and Odor Control.....E. A. Sigworth
Testing for Radioactivity in Public Water Supplies.....J. S. Ameen
Progress in Abatement of Water Pollution Under Public Law 660.....C. H. Atkins
Filmstrip:
The Story of Water Supply
Motion Pictures:
Lifeblood of the Land
Pure Water and Public Health
Waters of the Commonwealth

North Central Section—Sep. 24–26, 1958

What's New in Pump Maintenance.....O. M. Kristy
Membrane Filter Technique.....Russell Frazier
Iron Removal From Ground Water Supply—Panel Discussion
Elmer Huset, Charles Carl & W. Van Heuvelen
St. Cloud's New Plant.....Fred Thielman
Water Works Management.....Lauren Grayson
Design of Cast-Iron Pipe for Intermediate Depths.....W. Harry Smith
Maintenance of Mains—Panel Discussion
Cause and Prevention of Leaks.....W. Harry Smith
Tools and Equipment.....Clarence H. Nelson
Technique of Leak Detection.....George Johnson
Safety and First Aid Demonstration.....Wheeler Van Steinberg
Corrosion and Corrosion Protection—Panel Discussion
Corrosion.....Earl H. Ruble
Paint and Protective Coatings.....L. P. Kahler
Cathodic Protection.....Claude Clarke
Corrosometer.....C. W. Callaghan
Filmstrip:
The Story of Water Supply
Motion Picture:
Lifelines for Civilization

Ohio Section—Sep. 17–19, 1958

Address of Welcome.....*Mayor* Anthony J. Celebrezze
Future Water Supply for the City of Toledo and Lucas County....Carleton S. Finkbeiner
Taste and Odor Problems in Ohio in Comparison With the United States
E. A. Sigworth
Feeder-Main Relocation Problems Brought About by Freeway Development in Cleveland
Frank Schwemler
Employee Safety—Whose Responsibility?.....O. C. Haier
Modern Water Works Accounting Procedures.....F. Joseph Rachor
An Appraisal of the Public Employees Retirement System.....E. A. Engert
Plant Operation and Problems—Discussion.....*Led by* M. M. Schirtzinger
Develop Your Water Program Now.....John C. Bumstead
Changing Philosophies in the Development of Water Facilities.....Wendell R. LaDue
Elevated Storage Tank Maintenance.....Kenneth O. Kessler
Thirty-seven Years of Recarbonation.....Donald Hazelswart
Location and Evaluation of Ground Water Resources.....Lynn M. Miller
Lime-Soda Softening With Coagulants Other Than Alum.....John Hess
Collection of Delinquent Accounts.....Ralph S. Locher
Legislative Report.....Raymond H. Fuller
The Role of the District Engineer in the Supervision of Municipal Water Works
Messrs. Griffin, Robinson, Singer, Spies & Wagoner
Operating Characteristics of Rapid Sand Filters.....H. E. Hudson
Motion Pictures:
The Manufacture of Cast-Iron Pressure Pipe
Water—From Plans to Plenty

Pacific Northwest Section—May 15–17, 1958

Address of Welcome.....*Mayor* Willard Taft
Legal Responsibilities in Water System Operation.....Ernest H. Campbell
A Program for Water Resources Development in Washington.....Robert Seeber
Operation Bootstrap.....Fred Merryfield
Plastic Pipe Experiences—Panel Discussion.....
Bert S. Montell, Ralph L. Morgenthaler, Fred Ovenell & William Hewat
Rehabilitation of Small Water Systems.....
Kenneth Bielman, Joseph Custer, Arthur Musgrave & Kenneth Rinard
Effects of Metering on Water Demand in Richland.....Harold N. Petty
Watershed Operation and Maintenance.....
Ernest Rogers, N. J. Salmon, William E. Bullar, Harold Buroker & Lewis S. Finch
Water Treatment.....
C. F. Whetsler, Winston H. Berkeley, C. R. Harlock, Warren Westgarth, Walter R. Conley Jr., John Berning & Archie Rice
Ground Water Operation.....Paul Meyer, Howard Harstad, Ray Schruers & Walter Smith
Operation Helpmeet.....Lewis S. Finch
Motion Picture:
Engineering Your Health

Pennsylvania Section—Jun. 24–26, 1958

Address of Welcome.....*Mayor* Arthur J. Gardner
Erie Water Works.....J. D. Johnson
Water Works Advancement Program.....John H. Murdoch Jr.
Water Works Safety.....V. A. Appleyard

Water Conservation and Development in Pennsylvania.....Maurice K. Goddard
Hydraulics of Water System Planning.....M. B. McPherson
Effect of Valve Operation on Water Hammer.....S. Logan Kerr
Automatic Operations of Filter Plants
Operators' Viewpoint.....John J. Hamilton
Designers' Viewpoint.....R. A. Falciani
Treatment Problems with Low Stream Flows—Discussion.....*Led by* K. C. Armstrong, J. D. Beck, B. French Johnson & K. E. Shull

Rocky Mountain Section—Sep. 15–17, 1958

Address of Welcome.....Roy L. Cleere
AWWA Water Works Advancement Program.....Lewis S. Finch
The Application of Coagulant Aids in Drinking Water Clarification
Christopher P. Blakeley
Review of AWWA Policy on Recreational Use of Reservoir Areas.....Lewis S. Finch
The Financing of Water and Sewage Works Projects.....Owen Moore
Why Prestressed Concrete Tanks for Water and Sewage Works?....Charles P. Shelander
Radioactive-Waste Control in Relation to Water Supplies and Sewage Disposal
Ernest C. Tsivoglou
Discussion.....William N. Gahr
Conservation of Water for Beneficial Uses as Related to P. L. 660.....Robert Ayers
The Variable-Flow Transmission of Sewage and Water.....George Osgood
Committee Report on Conservation of Water Supplies in the Rocky Mountain Area
John W. Clark
Report From Colorado.....V. A. Vaseen
Report From New Mexico.....John W. Clark
Report From Wyoming.....Arthur E. Williamson
Motion Picture:
Engineering Your Health

Southeastern Section—Mar. 23–26, 1958

Address of Welcome.....*Mayor* William B. Hartsfield
AWWA's Public Information Program.....Fred Merryfield
Lawyer's Observations on Financing Municipal Utilities.....Huger Sinkler
Atlanta's Water Works Expansion Program.....Paul Weir
Flocculation Practices.....C. A. Obma
Effects of Impoundments Upon Water Use—Panel Discussion
M. A. Churchill, Robert S. Ingols, Frederick F. Fish & B. M. Hall Jr.
Availability and Application of Digital Computers to Water Utility Problems.....
William F. Atchison & M. R. Carstens
Current Practices in Well Development in the Southeast...Allen A. Sickel & John M. David
Report on Use and Performance of Plastic Pipe.....Richard King
Taste and Odor Experiences in the Southeast Compared to the Entire United States.....
E. A. Sigworth
Taste and Odors—Panel Discussion.....*Led by* M. E. Henley, Charles H. Starling, H. J. Webb, J. D. Lesslie & E. A. Sigworth

Virginia Section—Nov. 5–7, 1958

Norfolk's Experiences with Millipore Filtration.....W. G. Beazley
Hazards From an Industrial-Hygiene Standpoint in the Water Works Industry
Richard H. Mansur
Discussion of Short School for Operators.....W. W. Anders

Discussion of Operators' Voluntary Certification Plan.....H. E. Lordley
Answering the Customers' "Whys"—Panel Discussion.....*Led by* Brent Remsburg, James W. Head Jr., George W. Brown & W. M. Sterrett
Is Your Water System Providing Adequate Fire Protection?.....Kenneth J. Carl
Penny-Wise Water.....Lewis S. Finch
Industrial Reuse of Water.....Ralph E. Fuhrman
Adequate Supervision of Construction.....R. Kenneth Weeks
Advancement of the Water Works Industry.....James B. Corey
The World Wants for Water Wisdom.....Edwin Cox
Filmstrip:
The Story of Water Supply
Motion Pictures:
Water—From Plans to Plenty
Lifelines for Civilization

West Virginia Section—Oct. 23–24, 1958

Address of Welcome.....*Mayor* John T. Copenhaver
Training for Operation of Automatic Equipment in Water Works and Sewage Treatment Plants.....William Firth
Radioactive Materials in Water.....Harry P. Kramer
Water—A Vital Problem Today.....Walter C. Gumbel
Steam and Condensate Line Corrosion.....Paul M. Spurney
Water Treatment for Air Conditioning.....R. G. Dalbke
Probable Accuracy for Proportional Pacing Systems.....Frank Russo
The Plant Manager's Approach to Low-Pressure Complaints.....Nick I. Leshkow
The West Virginia Section and the Water Works Advancement Program
John H. Murdoch Jr.
Experiences With Use of the Membrane Filter.....Frank J. DeFranco
Demonstration and Discussion of the Membrane Filter.....Frost B. Claiborne
Mud Tub Lecture.....C. A. Erickson
Operating and Management Problems—Panel Discussion.....*Led by* J. J. Dwyer
Legal and Management.....John H. Murdoch Jr.
Management.....Max K. Jones
Engineering.....Harry K. Gidley
Purification.....A. E. Griffin
Motion Pictures:
This Is Your Valley
Four Hundred Million Gallons per Day

Wisconsin Section—Sep. 17–19, 1958

Address of Welcome.....*Mayor* Ben C. Schuck
Opening Remarks.....Harvey E. Wirth
A Study to Improve the Treatment of Lake Michigan Water.....Merrill B. Gamet
The Rehabilitation of Rock Wells.....C. F. Briggs
Restoring Capacity of Screened Wells.....E. W. Hudgens
Discussion.....Merrill B. Gamet, E. W. Hudgens, C. F. Briggs, John M. Rademacher & Morris O. Nelson
Variable-Speed Pumps, Their Motor and Controls.....Roy Brown
Economics of Vertical-Turbine Pump Operation.....Kenneth Moehrl
Discussion.....Roy Brown, Kenneth Moehrl, Carl H. Lindeman, Warren E. LaLande & Arno T. Lenz
Proper Selection of Water Storage Units.....Bruno J. Hartman

Maintaining Reservoirs and Tanks.....William Hammann Jr.
Discussion.....Bruno J. Hartman, William Hammann Jr., Ceaser A. Stravinski & Carl Wahlstrom
Safety Is Everybody's Business.....Thomas F. Allen
Certification of Water Works Operators.....William U. Gallaher
Water Resources Legislation.....Arthur J. Jark
Public Information Program.....Gerald A. Rohlich
Water Works Safety Program.....William Hammann Jr.
AWWA Membership.....Edmund T. Malinowski
Motion Pictures:
Underground Arteries
Knowing's Not Enough

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Section Meetings—1954–58

Section	*1954*	*1955*	*1956*	*1957*	*1958*	*Meeting Place—1958*
Alabama-Mississippi	Oct. 24–27	Oct. 30–Nov. 2	Oct. 21–24	Oct. 20–23	Sep. 28–Oct. 1	Biloxi, Miss.
Arizona	Apr. 22–24	Apr. 14–16	Apr. 5–7	Apr. 4–6	May 15–17	Tucson, Ariz.
California	Apr. 9*	Apr. 15*	Apr. 13*	Apr. 26*	——	——
	Oct. 26–29	Oct. 25–28	Oct. 23–26	Oct. 29–Nov. 1	Oct. 28–31	Los Angeles, Calif.
Canadian	Apr. 12–14	Apr. 18–20	Apr. 23–25	Jun. 17–19	Jun. 1–4	Toronto, Ont.
	Oct. 4–5†	Oct. 17–18†	Oct. 15–16†	Oct. 17–18†	Oct. 1–3	Fredericton, N.B.
Chesapeake	Oct. 27–29	Oct. 26–28	Oct. 24–26	Oct. 30–Nov. 1	Oct. 29–31	Wilmington, Del.
Cuban	——	Dec. 1–3	Nov. 29–Dec. 1	§	——	——
Florida	Nov. 7–10	Nov. 6–9	Nov. 11–14	Nov. 10–13	Oct. 19–22	North Miami Beach, Fla.
Illinois	Mar. 17–19	——	Mar. 21–23	Mar. 20–22	Mar. 26–28	Chicago, Ill.
Indiana	Feb. 10–12	Feb. 9–11	Feb. 8–10	Feb. 6–8	Feb. 5–7	Indianapolis, Ind.
Intermountain	——	——	——	——	Nov. 6–7	Salt Lake City, Utah
Iowa	Oct. 13–15	Oct. 19–21	Oct. 24–26	Oct. 16–18	Oct. 15–17	Des Moines, Iowa
Kansas	Apr. 7–9	Apr. 13–15	Apr. 4–6	Apr. 10–12	Mar. 12–14	Salina, Kan.
Kentucky-Tennessee	Sep. 20–22	Sep. 12–14	Sep. 17–19	Sep. 23–25	Sep. 22–24	Memphis, Tenn.
Michigan	Sep. 15–17	Sep. 14–16	Sep. 12–14	Sep. 25–27	Sep. 8–10	Grand Rapids, Mich.
Missouri	Sep. 26–28	Sep. 25–27	Sep. 30–Oct. 2	Sep. 29–Oct. 1	Sep. 28–30	Jefferson City, Mo.
Montana	Apr. 23–24	Apr. 29–30	Apr. 6–7	Apr. 4–6	Mar. 20–22	Missoula, Mont.
Nebraska	Apr. 22–23	Apr. 13–15	Apr. 11–13	Apr. 24–26	Apr. 16–18	Lincoln, Neb.
New England	——	——	——	——	——	——
New Jersey	Nov. 4–6	Oct. 20–22	Oct. 18–20	Oct. 24–26	Oct. 23–25	Atlantic City, N.J.
New York	Apr. 22–23	Apr. 20–22	Apr. 18–20	Apr. 10–12	Mar. 26–28	Schnectady, N.Y.
	Sep. 9–10	Sep. 7–9	Sep. 12–14	Sep. 11–13	Sep. 10–12	Lake Placid, N.Y.
North Carolina	Nov. 8–10	Nov. 14–16	Nov. 12–14	Nov. 11–13	Nov. 10–12	Greensboro, N.C.
North Central‡	Oct. 6–8	Oct. 5–7	Sep. 12–14	Sep. 25–27	Sep. 24–26	Duluth Minn.
Ohio	Sep. 22–24	Sep. 21–23	Sep. 19–21	Sep. 18–20	Sep. 17–19	Cleveland, Ohio
Pacific Northwest	——	May 19–21	Apr. 26–28	May 2–4	May 15–17	Spokane, Wash.
Pennsylvania	Jun. 23–25	May 4–5	Apr. 3–5	Jun. 12–14	Jun. 25–27	Erie, Pa.
Rocky Mountain	Nov. 9–10	Sep. 19–21	Nov. 26–28	Sep. 23–25	Sep. 15–17	Denver Colo.
Southeastern	Mar. 29–31	Mar. 20–23	Mar. 18–21	Mar. 17–19	Mar. 23–25	Atlanta, Ga.
Southwest	Oct. 17–20	Oct. 16–19	Oct. 14–17	Oct. 13–16	——	——
Virginia	Nov. 3–5	Nov. 3–5	Nov. 7–9	Nov. 6–8	Nov. 5–7	Richmond, Va.
West Virginia	Nov. 8–9	Oct. 20–21	Oct. 31–Nov. 2	Oct. 23–24	Oct. 23–24	Roanoke, W.Va.
Wisconsin	Sep. 28–30	Sep. 21–23	Sep. 26–28	Sep. 4–6	Sep. 17–19	Wausau, Wis.

* Regional meetings. † Maritime Branch. ‡ Formerly Minnesota Section. § Meeting Canceled.

Section Membership at Time of, and Total Attendance at, Section Meetings—1954–58

Section	1954		1955		1956		1957		1958	
	Membership	Attendance	Membership	Attendance	Membership	Attendance	Membership	Attendance	Membership	Attendance
Alabama-Mississippi	189	311	206	257	219	318	224	307	235	279
Arizona	76	199	68	157	77	156	84	234	104	170
California§	1,193	1,709	1,291	1,037	1,378	1,253	1,451	1,225	1,601	1,710
Canadian§	608	848	629	714	663	816	708	500	730	922
Chesapeake	248	210	258	211	267	191	288	228	306	157
Cuban	69	‖	54	*	52	43	62	‖	58	†
Florida	328	305	342	306	355	331	361	399	385	460
Illinois	504	474	527	‡	557	468	589	474	650	509
Indiana	332	399	392	475	409	421	478	499	525	602
Intermountain	**	**	**	**	**	**	**	**	76	107
Iowa	133	191	137	286	149	220	181	282	189	289
Kansas	220	191	229	208	237	236	239	217	259	228
Kentucky-Tennessee	189	294	201	259	221	317	252	317	268	368
Michigan	386	263	411	236	435	278	471	341	505	335
Missouri	198	260	206	230	228	275	238	306	246	289
Montana	55	117	57	76	54	84	61	132	64	154
Nebraska	95	200	94	164	103	183	109	156	107	63
New England	218	†	225	†	233	†	248	†	258	†
New Jersey	436	340	435	313	463	351	505	336	531	370
New York§	805	420	826	315	851	429	882	458	884	505
North Carolina	191	255	202	281	232	326	224	305	215	*
North Central#	241	179	238	162	260	157	278	177	260	199
Ohio	445	406	468	251	482	253	508	281	517	334
Pacific Northwest	441	‡	440	293	438	304	507	358	500	398
Pennsylvania	465	234	493	255	516	295	558	235	560	251
Rocky Mountain	170	100	171	94	186	164	237	152	205	166
Southeastern	246	313	267	325	278	319	300	335	326	446
Southwest	945	681	1,047	850	1,086	889	1,133	784	1,113	‡
Virginia	188	230	192	237	207	233	213	241	216	216
West Virginia	103	212	100	152	104	126	105	195	112	201
Wisconsin	182	316	190	291	199	296	206	340	216	319

* No record of attendance.
† No regular meeting scheduled. Membership given as of dates of conferences.
‡ Regular meeting canceled. Business meeting held at annual conference.
§ Only one of section's meetings recorded here.
‖ Meeting canceled.
Formerly Minnesota Section.
** Section organized in 1958.

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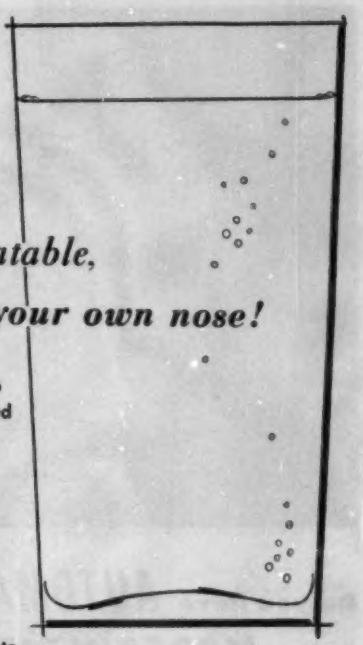

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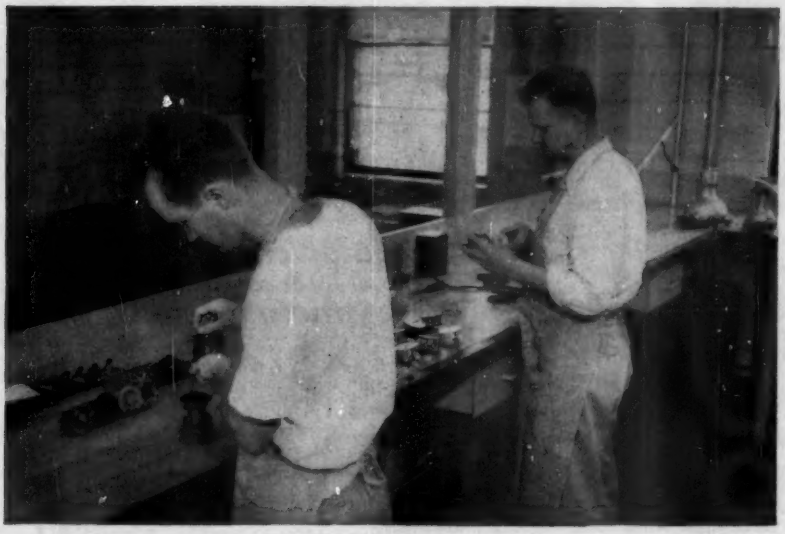

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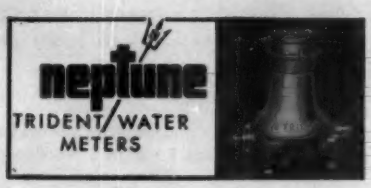

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Merry Christmas

Not Willing Water, but 57 other guys are really behind that beard—the 57 unpaid, unsung, and un-even-identified active members of Editors Anonymous—that entirely unorganized society of preservers of P&R. Of course, it takes the Christmas spirit each year to inveigle our admission that these Santa Cli have been giving us presents all year long—the wherewithal we wear with all immodesty throughout these columns.

In other years the disanonymization process has been attended by a classification procedure whereby recognition of the extent of dogoodery by each member has been attempted. By now—the eleventh year of editorial anonymity—however, so much good has been done by so many for so long that we have had to start counting in years of contributions rather than in number of clippings contributed. Thus, the list below indicates just how powerful be the powers that be in superscribing the years of their affiliation. And even recognizing that member anonymity has ranged all the way from a single unintended contribution to a meant monthly many, we must content ourselves with pointing out that among those unbearded below are three all-powerful ones—Ellsworth Filby, Joe Wafer, and Syd Wilson—who have headed the list of anonyms from the very beginning. Merry Christmas, then, to our

EDITORS ANONYMOUS

V. H. Allen[8]
F. C. Amsbary[8]
W. W. Aultman[8]
H. W. Badley[8]
Don Berkow[8]
C. H. Capen[10]
E. J. Cleary[3]
D. C. Colebaugh[4]
J. G. Copley[8]
N. M. deJarnette[7]
J. M. Diven[7]
J. E. Drudy[3]
H. A. Faber[3]
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E. L. Filby[11]
D. N. Fischel[10]
M. E. Flentje[7]
R. V. Ford[2]
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Warren Gold[2]
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R. E. Hansen[7]
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R. L. Johnson[1]
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W. R. LaDue[5]
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W. T. Longstreth[1]
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Mildred Merryfield[9]
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W. C. Westgarth[1]
Henry Wilkens[6]
D. B. Williams[7]
P. S. Wilson[11]
William Yegen[3]
J. F. Zieserl[8]

And in saying more power to them, we hope that we may be wishing you as well as ourself a Happy New Year!

(Continued on page 36 P&R)

(*Continued from page 35 P&R*)

The time has come, some of his colleagues feel, to strip the mask off the peerless P&R-petrator whose monthly musings and amusings have been appearing in these columns for some years now. As he's a shy bird, we had to photograph him secretly in the dark, with the rather mysterious result above, but we nearly managed to catch his name. It's Eric Something-or-Other. Jansen, or Yonson, or like that. (There's an Eric Johnson who is listed on page 2 P&R as AWWA's Assistant Secretary for Publications—a coincidence, no doubt, because *that* Johnson is a serious-minded fellow responsible for seeing to it that the JOURNAL, *Willing Water,* and other AWWA publications get published instead of just talked about.) We're still on the trail, though, and we'll get our man yet!

Our 'Do It Now!' program promises to become not only a whodunit, but a whodunwhat, when, and where, unless someone does something soon about pinning down construction statistics. Right now we can show at least a $100,000,000 boost in water works construction in a month (due, of course, to "Do It Now!") merely by switching from one set of authoritative figures to another. Everyone, it seems, collects statistics, but no two collectors have the same taste. Thus, the totals for public water supply construction in 1957 can be correctly quoted at from $368,000,000 to $698,000,000. Variously, these quotes line up like this:

Collector	Basis	1957 Total *$1,000,000*
Engineering News-Record	contracts let	368
Construction Review	contracts let	415
US Public Health Service	contracts let	457
Bureau of the Census	contract expenditures	556
Construction Review	put in place	562
Bureau of the Census	capital expenditures	698

All of these figures, of course, take quite a bit of explaining. *Engineering News-Record,* for instance, ignores all contracts smaller than $44,000 and does not include force-account work. USPHS includes all contracts that are strictly for water works, plus the water works portions of combination contracts, and $15,000,000 of "owner builds" projects, obtaining its basic information from F. W. Dodge Corp. reports and from its field representatives and state health departments. *Construction Review,* a joint publication of the federal commerce and labor departments, also depends on *Dodge Reports* for basic information and supplements that with data supplied by a number of the larger municipalities; its "put in place" figure includes cost of clearing and development of site, materials, service facilities, labor, overhead, and profit, as well as architectural and engineering fees, and force-account work. The Bureau of the Census figures do not include cost of land or existing buildings, but its totals of capital expenditures include contracts, force-account work, and equipment.

To extend the range even further, the Water & Sewerage Industry & Utilities Div. of the Dept. of Commerce Business & Defense Service Adminis-

(*Continued on page 38 P&R*)

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(*Continued from page 36 P&R*)

tration adds to the census figures its own estimate of construction for private water systems, including those put in by real estate developers, and arrives at a grand 1957 total of $837,700,000.

As if the figures didn't lead to enough confusion, the figurers are doing their bit, too, with the Dept. of Labor and the Dept. of Commerce battling hard for the right (and money) to collect and to interpret construction statistics, while the Budget Bureau is tightening the purse strings in an effort to choke off the struggling. As a matter of fact, there are undoubtedly more than enough figures to go around, so that restoration of statistical peace and establishment of some kind of order in the counting houses could mean a millennium in millioning for all concerned.

Meanwhile, whichever of these million-marks you prefer, the marker is certain to agree that water works need much more doing—much, much more doing—to be able to keep up, much less catch up. *Do it now!*

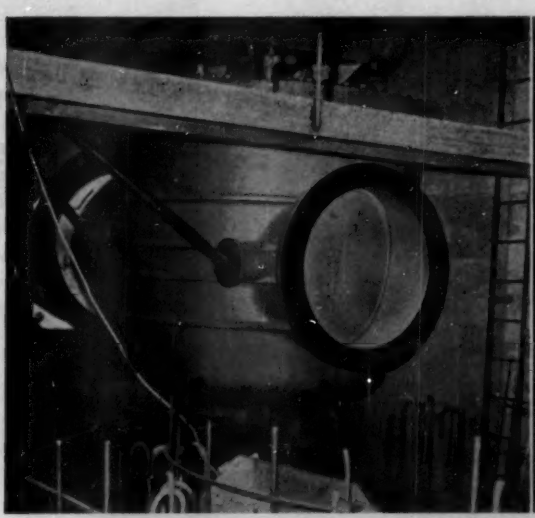
Speaking of statistics reminds us to point out that, regardless of statisticians, the capital investment in water works has by now grown to a total of almost $15 billion. That, by the way, is book value, not replacement cost, for, whereas an average of more than $250 per capita is required to provide public water supply today, dividing the investment among the 130,000,000 present population served brings the overall investment per person down to $115. And, at last count (1955), water utilities had an investment of $8.80 for every dollar of revenue.

Lest you get concerned about book value in terms of a population increasing at a rate that will mean doubling the number served by the end of the century, take comfort in the fact that the number of technical articles published will have doubled twice by then. Talk about *book* value!

Hula hoops, those spinning things that have given us a nation of pint-size Elvis Presleys, have even had an impact on the water works field. Not that Lew Finch, Lauren Grayson, Bill Orchard, or Harry Jordan has yet been caught undulating or circumvolving in such manner as to support a swing ring, but at least one company in the plastic water pipe business—the Kansas Plastic Pipe Co. of Wichita—has turned its capacity to the task of building thirsts instead of helping to slake them. Meanwhile, word from the aluminum industry indicates that some of its tubing may also start spinning. From the cast-iron pipe manufacturers, however, we have word that not until Elvis himself needs another will they again get involved.

It's an education that the Long Beach, N.Y., water department, as well as the local gas, telephone, and electric utilities, helps pay for—or, rather, helps collect for—through a 3 per cent school tax added to all utility bills. Just what the logic is we haven't quite determined yet, unless it depends on the relationship between, first, diaper wash, and, later, teen-age telephoning and educational requirements. Of course, Long Beach is a summer resort area, but it hardly seems likely that year-rounders would legislate to their own disadvantage. At any rate, it must make nonpayment of utility bills juvenile delinquency.

(*Continued on page 40 P&R*)



This SMS-Rotovalve at Iron Mountain shows clearly the drop-tight shut-off position. In operation, the conical plug first lifts, then turns, finally reseats, giving you precise aperture control.

3 MORE SMS-ROTOVALVES ORDERED FOR PUMP DISCHARGE SERVICE AT IRON MOUNTAIN

As part of the expansion program for increasing the supply of water to southern California through the Colorado River aqueduct, three more SMS-Rotovalves have been ordered by the Metropolitan Water District of Southern California. These three 48″ x 64¼″ tapered Rotovalves, duplicates of six already installed at Iron Mountain Pumping Station, will be used for pump discharge service. Their inherent characteristics of a large reduction of flow area during the early part of the closing stroke make them ideally suited to control surges in the event of emergency shut-off.

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(*Continued from page 38 P&R*)

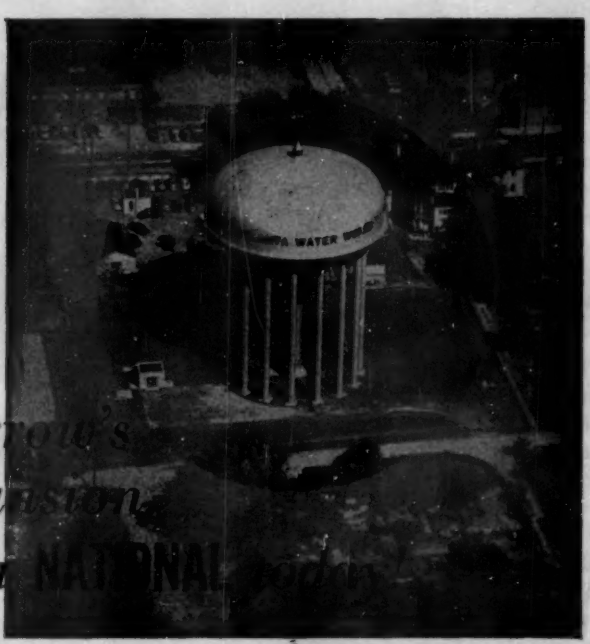
Not fire, but the stuff with which to extinguish it, is pouring out of the plane pictured below, one of three Avenger aircraft brought to the Fraser Valley in British Columbia last summer to help control forest fires there. This high dropper technique of getting at the very heart of the fires developed from the earlier practice of bombing the burning areas with paper sacks full of our favorite fluid. Now, the tanks of these new firefighters carry 600 gal, which, released not too high above treetop level, penetrates to the base of the trees, where fires are hardest to extinguish. Something new in water distribution systems, really, with *very* elevated tanks.

Courtesy Vancouver Sun

Not water, but fire came out of the hoses of firemen at Elizabeth, N.J., last month, when they started spraying a small brush fire in the industrial area. And the further they opened the hydrant to which their hoses were attached, the hotter and higher the blaze grew. It took a stream from a hydrant half a mile away to get things under control. Meanwhile, investigation proved that someone at the Crown Central Petroleum Co., which maintained the fiery hydrant, had cross-connected the water line and one carrying a "highly flammable mixture of gasoline and kerosene." Also something new in water distribution systems, and, only by luck, with no head loss.

Both water and fire was the story at Pueblo, Colo., at about the same time, when Mrs. Joseph Caps left a gallon jug of distilled water on the back seat of her car. The sun's rays

(*Continued on page 42 P&R*)



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(Continued from page 40 P&R)

through the water set fire to the upholstery, bringing out the fire department. But there, too, there could have been something new in water distribution systems if they hadn't been so all-fired impatient: the heat of the fire would certainly have broken the jug, letting the water get to work in a naturally automatic sprinkler system.

The Taft Sanitary Engineering Center announces two courses to be offered early next year. "Sanitary Bacteriology of Water," Jan. 26–30, is intended for professional bacteriologists, especially those in state, municipal, and other laboratories engaged in water analysis. Lectures and laboratory practice cover the MPN and membrane filter methods. The course will include: [1] basic information on bacterial indicators of pollution, new approaches in water bacteriology research, problems of viruses, epidemiology of waterborne disease, and statistics; [2] tube methods for examination of water for coliform and enterococcus groups, including analysis of laboratory data; [3] membrane filter equipment, culture media, sampling techniques, and practical applications.

The other course, "Radioactive Pollutants in Water," to be offered Feb. 16–20, will provide intensive training for water supply and water pollution control officials concerned with the radioactive contamination of water. Completion of the "Basic Radiological Health" course is a desirable prerequisite, as only a rapid review of radiation fundamentals will be made. Approximately 50 per cent of the course time will be devoted to laboratory practice, using commercially available sampling and monitoring instruments. Major topics will include: sources of radioactive pollutants in water, waste disposal criteria, stream sampling techniques, preparation of water and biota samples, laboratory counting techniques, gross radiation measurements, assay of specific radionuclides, establishment of water monitoring programs, relationship of water monitoring to other phases of environmental surveillance, and use of radiation in water analysis.

Applications for either course should be addressed to: Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Pkwy., Cincinnati 26, Ohio, or to a USPHS regional office director.

J. P. Lawlor has retired as president of General Filter Co., Ames, Iowa, a position he has held since he founded the company in 1935. His successor is Merlin H. Anderson, formerly vice-president. The other officers are Vincent M. Roach, vice-president, and Forrest R. Kenny, secretary-treasurer.

Keasbey & Mattison Co., Ambler, Pa., manufacturer of asbestos, magnesia, and asphalt products, has announced a number of management changes: Edward J. Buczkowski, formerly director of manufacturing, has been elected vice-president—production, while Robert A. Schneider, formerly technical director, has been elected vice-president—engineering. George Barge, treasurer, has been elected a director of the company and promoted to chief financial officer, succeeding W. L. Spielberger, who is retiring as director of finance after 21

(Continued on page 44 P&R)

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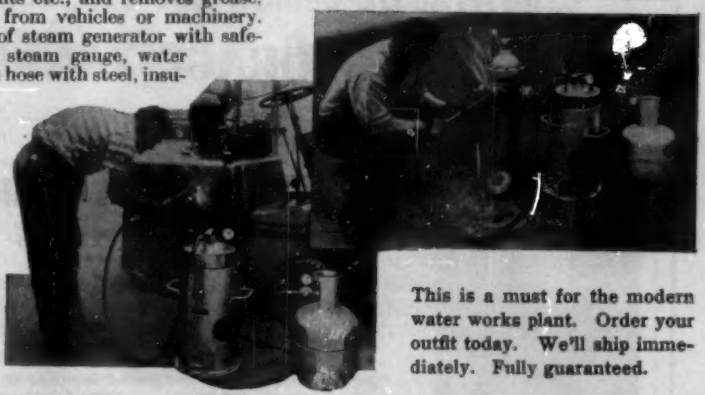

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(Continued from page 42 P&R)

years of service. Albert F. Humlhanz, formerly assistant to the treasurer, has been elected assistant treasurer and appointed controller.

Not water conversion, but water for converts is the job that a modern-day John Wesley has undertaken in accepting an assignment with the Methodist Board of Missions to drill wells and install water systems in Methodist mission stations throughout the central Congo. No ordinary well driller, Wesley is a full-fledged Purdue civil engineer with 5 years of experience in design and construction of public water supplies. The job is one that has been open for years, ever since the Methodist church sent a well-drilling rig over to the Congo and then found that no one knew how to operate it. As a matter of fact, Wesley spent the summer taking lessons on similar rigs and on how to live on a third of his previous income. In the latter respect at least, every water works man's a missionary.

Buffalo Meter Co., manufacturers of water meters for home and industry, has been purchased by Buffalo Niagara Industrial Controls, Inc., a subsidiary of American Meter Co. W. G. Hamilton Jr., president of American Meter, will also serve as president of the new acquisition. Dante Broggi, a vice-president of American Meter Co., will direct Buffalo Meter's operations through Russell Wetjen, who will be vice-president and general manager. Herbert F. Barrett will continue as sales manager.

(Continued on page 46 P&R)

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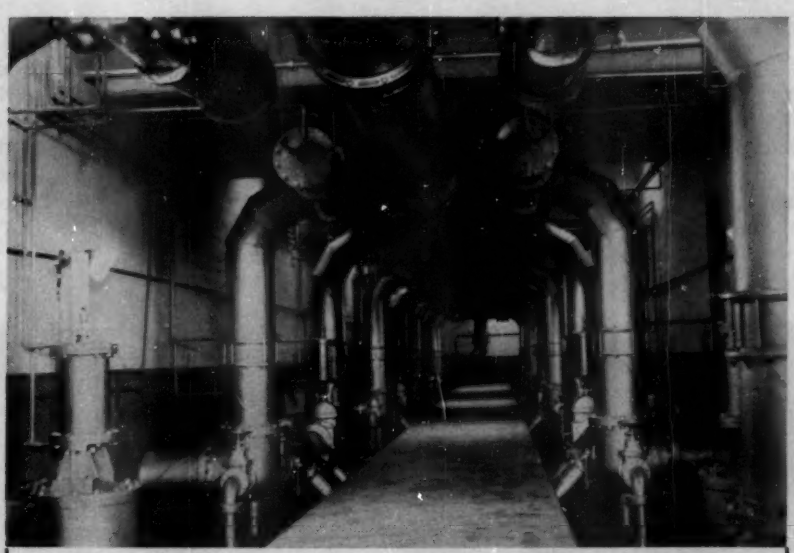

Armco Welded Steel Pipe installed in pipe gallery of El Placer Water Purification Plant, Quito, Ecuador.

Designers and Constructors: Harold T. Smith, International, S. A.

Armco Pipe and Welded Steel Fittings in Quito, Ecuador, Purification Plant

Quito, Ecuador's El Placer Purification Plant is one of the newest and most modern in South America. It serves a city of 225,000 persons with its daily capacity of 14.5 million gallons.

All piping in the pipe gallery of this plant is Armco Welded Steel Pipe with a coal-tar enamel lining. Fittings were fabricated from Armco Pipe by local welders.

You, too, will find that Armco Pipe offers the economical, efficient solution to water treatment and transmission problems. Diameters range from 6 to 36 inches; wall thicknesses from 3/16- to 1/2-inch. Linings and coatings are to AWWA Standard C-203.

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ARMCO WELDED STEEL PIPE

ARMCO

(Continued from page 44 P&R)

A new tub hubbub, now, 55 centuries after its invention, seems to be based entirely on the urge toward constant competition that characterizes our modern way of life. What other reason than the fact that 41,500,000 homes have bathtubs can there be for a Dallas lawyer to want a $3,000 one of Italian tile or, even, for a New Yorker to insist on a black and gold marble job, with gold and silver faucets, at $50,000? And what other reason for manufacturers suddenly to wake up to the fact that tubs, too, can be stylish and colorful and expensive? But it is the tendency toward spending more time in the tub rather than more money on it that is most directly traceable to the rigors of modern living. Almost as often as dirt, the need to relieve the tensions of the day is driving many moderns to seek the solace of those 90,000 Btu available in 30 gal of 110°F water. And that they stick around to soak them all in is indicated by the fact that washing is by way of becoming only an incidental of the bath. A Baking Soda Institute survey, for instance, indicates that popcorn, peanuts, and candy are now part of the equipage of a great many tubsessions. And it is further reported that: 12 per cent of

Hollywood's Helen Mowery enjoying the luxury of a "soft-water" bath in Dow Chemical Co.'s educational movie, "Soft as a Cloud," which has been seen by almost 25,000,000 people. Of course, we feel that Dow could have made its point a lot better and the movie a lot more educational by including a comparison with a hard-water bath.

(Continued on page 48 P&R)

Where water is used, process equipment and storage tanks are sure to corrode unless protected by an E.R.P. cathodic protection system. Even with these concrete high rate clarifiers at the St. Regis Paper Company plant near Jacksonville, Florida, it pays to protect the metal parts with an E.R.P. cathodic system.

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(*Continued from page 46 P&R*)

the nation's smokers enjoy a cigaret in the tub; 40 per cent of tubbists listen to music, from opera to rock and roll, while indulging; 25 per cent of all bathers read in the tub; and almost 6 per cent of tubbelles manicure their nails there. It should hardly be necessary, but it certainly seems wise to point out that it isn't the tub at all but the water that counts. And perhaps the more that it counts in this and other ways, the more chance that the present tensions of the water works field will one day be relieved—through the kind of relief, that is, that is now being banked by the confectioners, cigaret manufacturers, musicians, authors, and sundry other producers of the wherewithal of tub divertissement, not to mention the manufacturers of tubs, hot-water heaters, bath salts, and perfumes, and our friends in the water softener business. Anyway, the first 55 centuries are bound to be the hardest!

Seismograph is just another word for water well, according to the Geological Survey Div. of Michigan's Dept. of Conservation. Several observation wells in the state showed 0.1–1.2-ft oscillations in water level as a result of an earthquake that occurred in southeastern Alaska on Jul. 10. The compression waves traveling 3,500 mi through the earth's crust reached the Michigan wells in less than an hour.

James R. Dickerson has been named Los Angeles district sales manager for the Municipal & Utility Div. of Rockwell Mfg. Co. He was previously assistant products manager for the division at Pittsburgh. Jack D. Thurman has been appointed sales engineer for Los Angeles.

(*Continued on page 50 P&R*)

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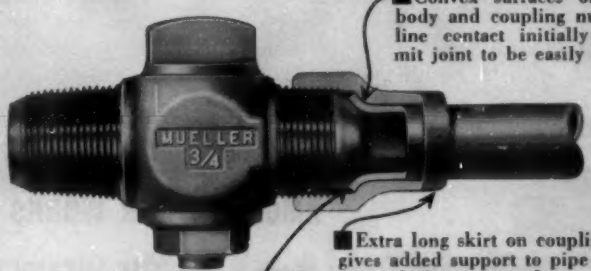

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(Continued from page 48 P&R)

The Institution of Water Engineers of Great Britain has elected AWWA Secretary Harry E. Jordan to honorary membership. Secretary Jordan plans to attend the IWE general meeting in 1959 to accept the certificate.

A one-man Point Four is water works man Harold T. ("Deep-Well") Smith, whose accomplishments have lately been given the recognition they deserve through, first, a story in *Latin American Report* for August 1958 and, then, a condensation in *Reader's Digest* for September 1958. In a career that started in a typhoid epidemic in Costa Rica and has carried him over most of the world, Smith has brought safe water supply and, with it, health and prosperity to countless communities in "underdeveloped areas" everywhere. Over the years he has put together a unique international organization through which he now has under way on three continents projects staffed by 262 engineers and technicians and 2,100 local laborers. The story of his single-handed development of one of the best Latin American water supplies for Quito, Ecuador—where they still drink "agua Smeeth"—together with equally unbelievable accomplishments elsewhere in the world, makes not only good reading, but particularly good publicity for the wonders of water. To Deep-Well Smith we make a low bow, not only for his water supply accomplishments, but for the statesmanship he has demonstrated in his international operations.

(Continued on page 52 P&R)

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You can obtain more information about the economies of Bitumastic 70-B enameled steel pipe from Koppers Company, Inc., Tar Products Division, Dept. 110H, Pittsburgh 19, Pennsylvania.

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ENAMELS

(Continued from page 50 P&R)

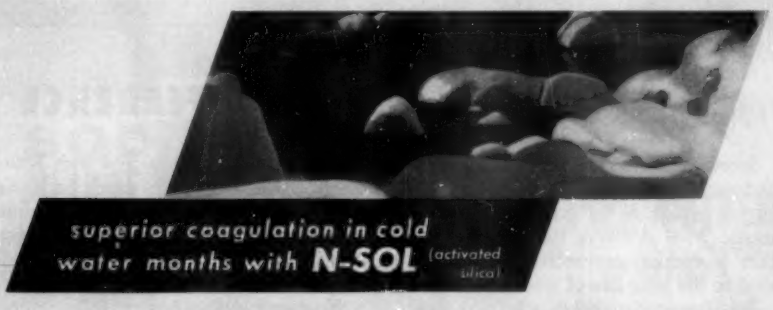
James E. Kerslake, incidentally, is taking over as superintendent of the 15-mgd filter plant at Quito and will spend 2 years training local personnel in its operation. Mr. Kerslake, filtration superintendent at Milwaukee, Wis., has performed valuable service for AWWA in directing the preparation of its chemical standards.

Fluoridation is just about old hat as far as news is concerned. True, only a little more than 33,500,000 people in 1,651 communities were drinking artificially fluoridated water by Jun. 1 of this year. And true that the 1958 increase to that date was only 221,222 people in 20 communities. But the "news" from each new fluoridating community is so much like the old stuff and the arguments of the pros and the cons are so familiar that they defy headlines.

From Philadelphia in September did come a headline, however, as the health commissioner's report after 4 years of fluoridation indicated an even greater reduction in dental caries than had been predicted. Studies on approximately 40,000 children in this first of the large cities to report indicated a reduction of 47 per cent in cavities and 43 per cent in extractions as the 4-year gain. Costs of the 1-ppm treatment averaged out at 7.6 cents per year per capita for the 2,000,000 population served.

Headlined in September, too, was the retirement of another of fluoridation's pioneers, Dr. W. L. Hutton, medical officer of health at Brantford, Ont. An early disciple of Dr. H. Trendley

(Continued on page 88 P&R)



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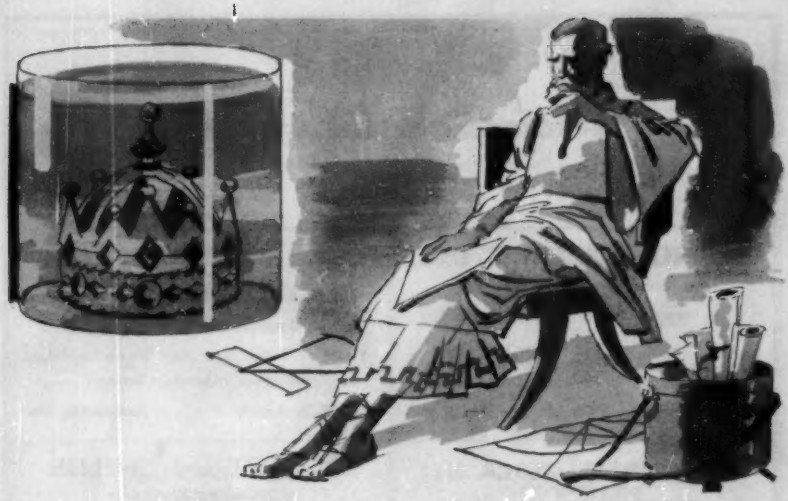
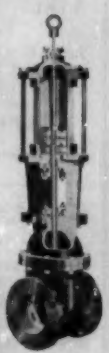


The Birth of HYDRAULICS

"Eureka!" (I have found it) cried the famous Greek sage Archimedes in the 3rd century B. C., as he discovered the principle of water displacement. But not until the 16th Century, A. D., many hundreds of years later, was the science of hydraulics really created when the French built the famous Fountains of Versailles near Paris.

Because water supplies are vital to life, ancient villages and camps had to be located near lakes or streams. Today, our modern civilization could not exist without the science of hydraulics which makes it possible to convey potable water in large quantities to distant centers of population. Instead of people going to the water, we now take the water to the people.

To a large extent, the men who manage and supervise our modern water distribution systems are unsung heroes. Like the stars in the sky or the cream in your coffee, they are "taken for granted." We believe that they deserve greater public recognition of their service.



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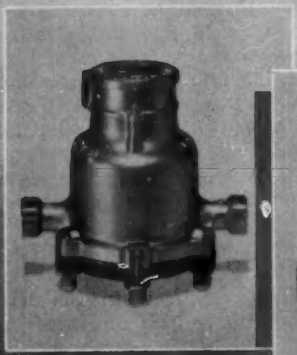

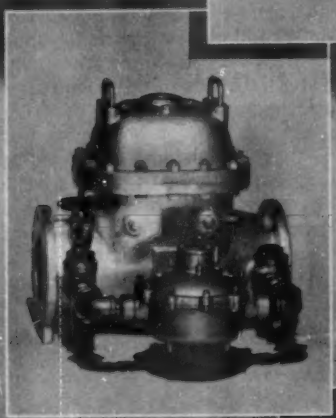

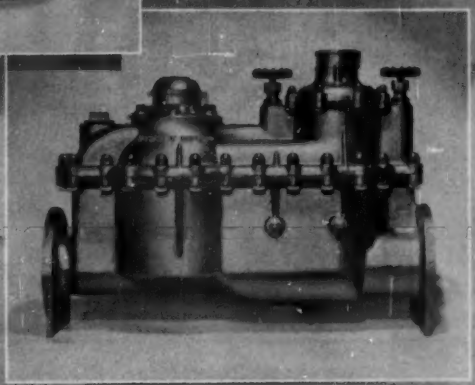

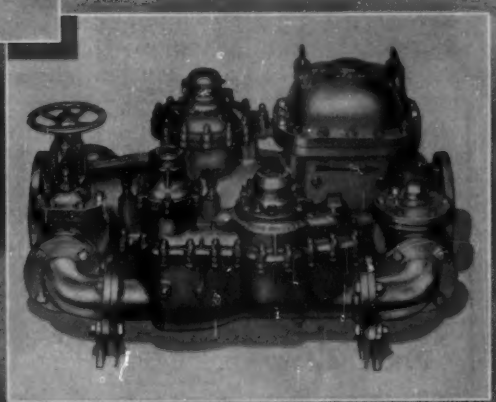

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Carabao * Anyone?

To the Editor:

How many water departments have trouble reports reading like this:

Nature of trouble: Broken water main.
Cause: Broken by carabao pushing main out of alignment.

The water mains on Guam are very near the surface, and in locations outside the villages are often aboveground. The carabao (water buffalo) make "wallow pits," and in so doing push everything out of their way.

Guam is the most westerly territory of the United States and is the southernmost and largest island of the Marianas group. It is 30 miles long and 4 to 8¼ miles wide. The central and northern portion is a broad, terraced plateau without streams, while the southern portion is quite mountainous and drained by numerous streams.

The average temperature is 74°–84°F with two seasons—dry and rainy. The rainy season extends from July through December. There is an average of 88 in. of rainfall in a year.

The Public Utility Agency includes the water, electric, and telephone systems, which are interconnected with the military establishments and many of the civilian communities. The present civilian population served is 38,578, distributed in 21 villages around the island.

The water facilities were originally designed and built by the military forces after the reoccupation, and the materials employed were intended for emergency and temporary use. These were later released to the government of Guam for the civilian population.

Maintenance, replacement, relocation, and extension have been the problems of the Water Div. New filtration and storage projects have been completed in the southern end of the island. Wells and springs are being developed in the central and northern parts to supply additional water and fire protection. The Water Div. has 6,708 meters in service, metering an average of 65 mil gal per month. A crew of 57 permanent employees does the maintenance, installation of new mains, filtration, pumping, chlorinating, testing, and repairing of meters. Meter reading and billing are under the accounting section for all utilities.

The projected capital improvement program for development and replacement is estimated at $2,109,000.

CHET EYER
Water Div. Mgr., Government of Guam
Agana, Guam
Oct. 31, 1958

* *Bubalus bubalis*, not *Rangifer caribou*.

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Chicago, Illinois	36"	7,200	2.6-3.6	New	147
New Orleans, La.	12"	39,650	1.2-2.9	New	143
Corder, Mo.	8"	21,350	0.9-2.3	New	143
Univ. of Illinois	8"	400	3.14	New	150
Concord, New Hamp.	14"	500	1.7-2.2	New	151
Concord, New Hamp.	12"	500	2.0-3.4	11	142
West Palm Beach, Fla.	12"	500	3.6-5.4	15	139.5
Greenville, S. C.	30"	67,376	2.4-2.7	12	148.5
Corpus Christi, Tex.	30"	65,641	1.1-1.8	6	146
Summerville, S. C.	8"	500	1.98-2.43	13	142.5
Champaign, Illinois	16"	3,920	3.1-5.6	22	139.3

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Condensation

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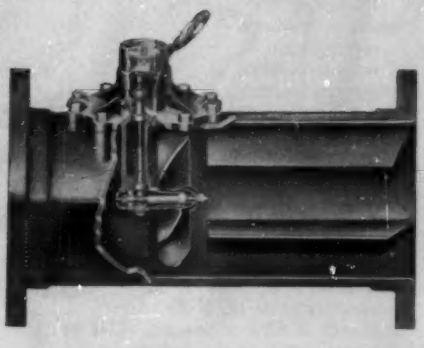

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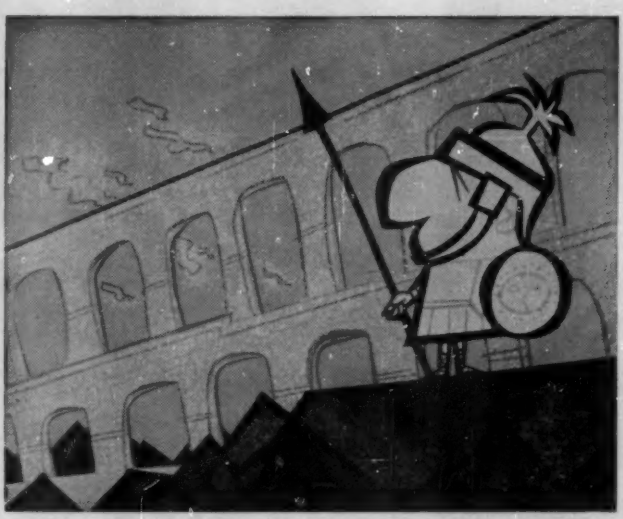

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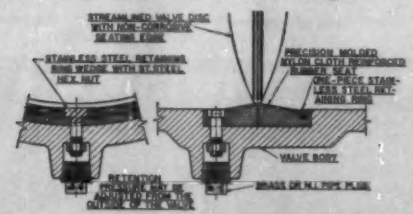
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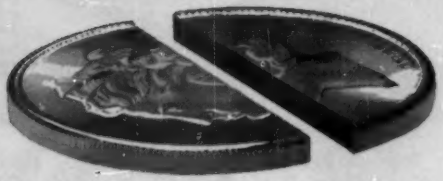

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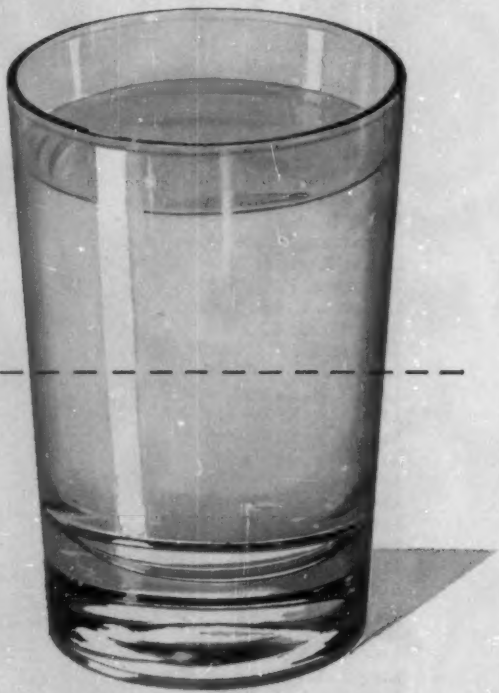

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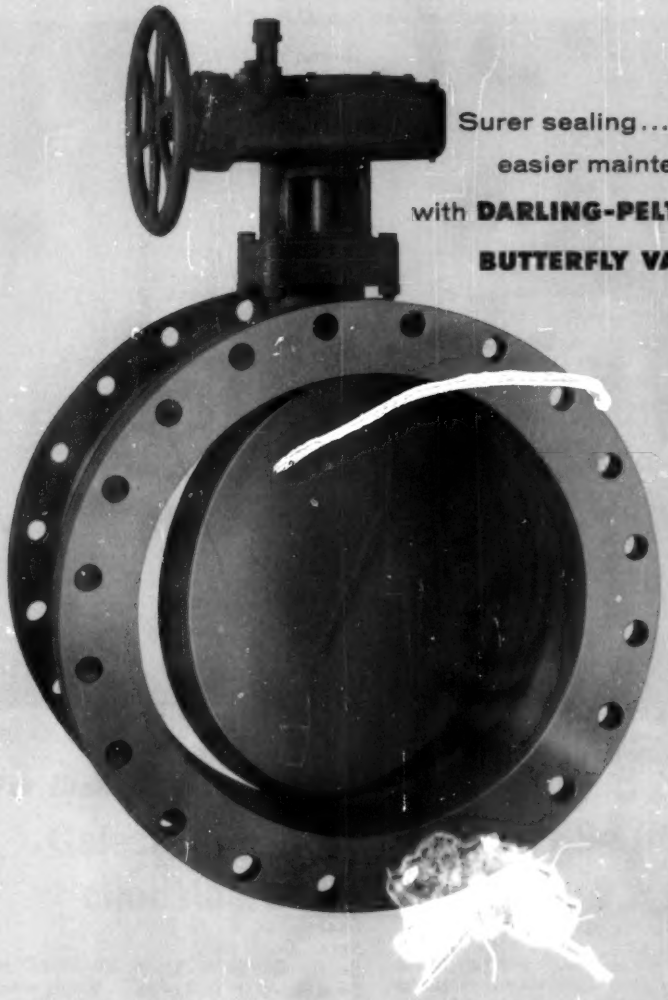

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Designed and supervised by: Casler & Stapleton, Consulting Engineers, Jacksonville, Ill.

For their 30-mile water line . . .

Galesburg, Illinois, saved $894,000 by choosing concrete pressure pipe!

In Galesburg, it's a long way to the town pump. With the local ground water level dropping 3 ft. per year, the nearest adequate supply was the Mississippi River substrata 30 miles away.

For the new pipe line needed, engineers chose concrete pressure pipe—in sizes up to 42" I.D. They saved almost $30,000 per mile, bids showed. They'll get trouble-free service, save on upkeep, too. Concrete has uniformly high strength right from the start—and actually grows stronger year by year.

Add low cost, water-tight joints, permanent high carrying capacity. You can see why more and more communities are using concrete pressure pipe to meet future population needs.

PORTLAND CEMENT ASSOCIATION

A national organization to improve and extend the uses of concrete

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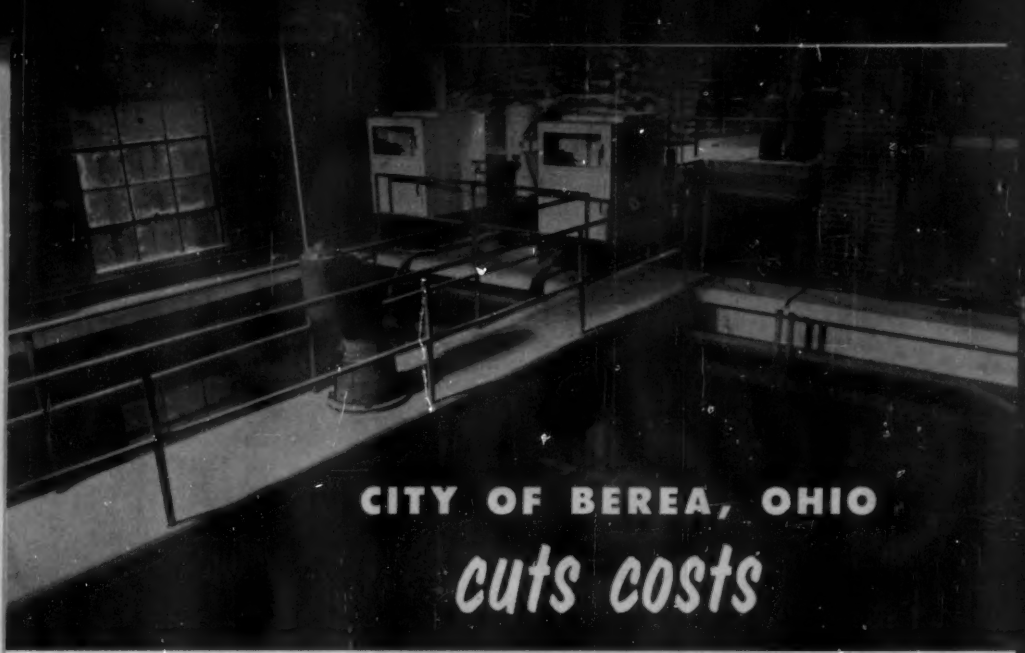

CITY OF BEREA, OHIO
cuts costs

New Cochrane SOLIDS-CONTACT REACTOR
combines
mixing, precipitation, sludge concentration, clarification & softening

The relatively hard, turbid Rocky River supply for the city of Berea, Ohio, is quickly reduced in hardness to approximately 3.5 gr/gal and to a turbidity of less than 10 ppm by the Cochrane Solids-Contact Reactor shown above. An existing concrete basin 28′ square x 15′ deep was modernized by conversion to the Solids-Contact type. Using hydrated lime, soda ash and alum, the Reactor treats over 2,000,000 gpd at surprisingly low cost.

Because the design of the Cochrane Reactor provides higher quality treated water faster, in less space, with minimum chemicals, their use has grown tremendously for municipal applications. High slurry strength in the reaction zone speeds precipitation—there is very little waste water. Automatic desludging saves time and labor. In addition to softening and clarification, Cochrane Reactors remove color, taste, odor; reduce alkalinity, silica, fluorides, etc.

Cochrane's background in water conditioning makes possible the installation of complete systems under a single responsibility for continued, consistent performance. Write for Publication 5001-A and case history reprints.

Cochrane also manufactures circular reactors

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Demineralizers • Hot Process Softeners • Hot Zeolite Softeners • Dealkalizers • Reactors
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(Continued from page 52 P&R)

Dean of USPHS, Hutton was the first to call for the addition of fluorides to a city water supply, and only the lack of chemical and equipment prevented Brantford from beating Grand Rapids to this "first."

The Sep. 13 issue of *Chemical Week* brought some interesting figures on the impact of fluoridation on the chemical industry, noting that as the procedure spread it gave a significant spurt to the output of fluoride chemicals, particularly sodium silicofluoride. Predicted output of this fluoride by the end of the year is 21,000 tons, nearly 40 per cent above the 1952 production of 12,700 tons, and about 8,000 tons (38 per cent) of this year's output will go to fluoridation. Output of the other chemicals for the year is estimated at 8,000 tons for fluosilicic acid, 1,600 tons for sodium fluoride, and 150 tons for miscellaneous fluorides.

Earlier in the year the WHO Expert Committee on Water Fluoridation issued its first report with these conclusions:

1. Drinking water containing about 1 ppm fluoride has a marked caries preventive action. Maximum benefits are conferred if such water is consumed throughout life.

2. There is no evidence that water containing this concentration of fluoride impairs the general health.

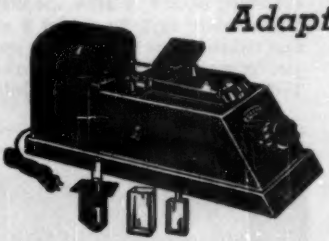
3. Controlled fluoridation of drinking water is a practicable and effective public health measure.

In July a system for fluoridating private water supplies, such as home wells, was announced. Consisting of either a

(Continued on page 90 P&R)

KLETT SUMMERSON
ELECTRIC PHOTOMETER

Adaptable for Use in Water Analysis



Can be used for any determination in which color or turbidity can be developed in proportion to substance to be determined

KLETT MANUFACTURING CO.
179 EAST 87th STREET • NEW YORK, N. Y.

Water Utilities in Many Cities "DO IT NOW!"

The timely "Do It Now!" program, launched last April by the AWWA to encourage communities to correct basic deficiencies in in their water systems and provide for vastly increased future water demands, is making headway fast.

Results of an AWWA survey show that many cities are now speeding up scheduled water works improvements projects, while others are blue-printing deferred plans. They are "doing it now" because they recognize that failure to provide an adequate water system can endanger public health and halt community progress.

When you "Do It Now" in your community, make sure that you don't have to dig up your water mains and "Do It Again" 10, 15 or 25 years from now.

Be sure to specify permanent

CAST IRON PIPE

The *proved* useful life of Cast Iron Pipe is at least double the estimated life of other pipe materials used for underground mains. Its maintenance cost is far below that of any other pipe material which has been in use long enough for the recording of conclusive data. That is why Cast Iron Pipe is rightly known as "America's No. 1 Tax Saver."

Our Company does not manufacture pipe but has long supplied the nation's leading Cast Iron Pipe manufacturers with quality iron from which quality pipe is made.

WOODWARD IRON COMPANY
Since 1882
WOODWARD, ALABAMA

(Continued from page 88 P&R)

hydraulic- or solenoid-actuated basement installation, the system was estimated to cost approximately $3 per month. Tried in four homes in the Maryland suburban area of Washington for 2 years, the method is such that a service group of the type that handles home water softeners could install and maintain it.

Not long after, ACS reported a new gadget for "do it yourself" fluoridation consisting of a 6-in. canister to be hooked on a water faucet, with a regulator to adjust dosage to specific needs. Its estimated cost of $130, however, does not compare very favorably with the approximately 30 cents per year per family reported for the Philadelphia installation.

"Old hat," for sure, with more and more communities trying it on. In New York, meanwhile, a survey of the "practical, technical, and engineering aspects" continues.

Benjamin B. Ewing has been named associate professor of sanitary engineering in the Dept. of Civil Engineering of the University of Illinois. He was on the University of California faculty from 1955 to 1958.

Chlorine production facilities at Pine Bluff, Ark., leased from the US government arsenal there, are now being operated by Arkansas Louisiana Chemical Corp., a newly formed subsidiary of Arkansas Louisiana Gas Co. When functioning at capacity, the plant will consume nearly 135 tons of salt daily in an electrolytic decomposition

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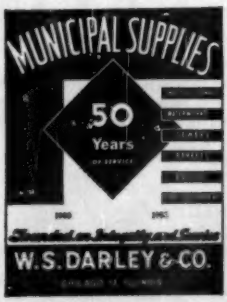

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For
100 PAGE CATALOG

W. S. DARLEY & CO. Chicago 12

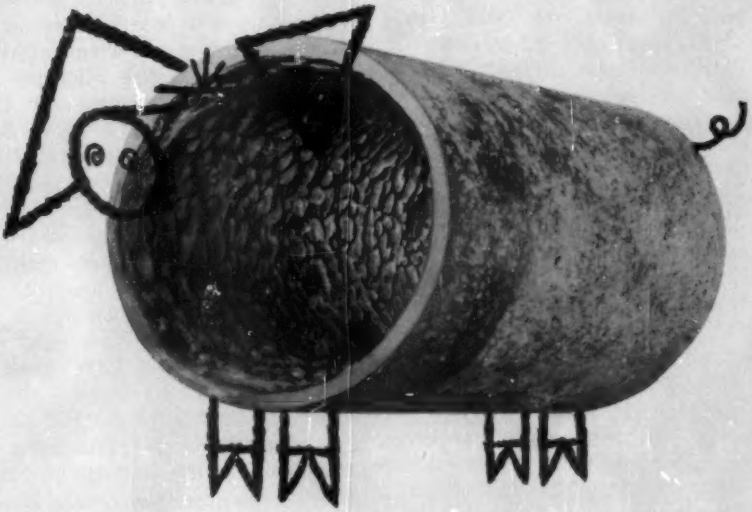
6 Reasons why
PALMER SURFACE WASH SYSTEMS
are specified by
water works engineers

1. Prevent Sand Beds From Cracking.
2. Eliminate Mud Balls.
3. Save Wash Water.
4. Lengthen Filter Runs.
5. Higher Rates of Filtration.
6. Better Tasting Water.

PHONE, WIRE OR WRITE TODAY FOR INFORMATION

STUART CORPORATION
516 N. CHARLES ST., BALTIMORE 1, MD.

portrait of a power hog



When water flow capacities go down and pumping costs go up, the culprit is usually *tuberculation*. The way to deal with this power hog is right on his own ground — the inner surface of the water main. Here Calgon,® the simple and inexpensive way to deal with corrosion,† goes to work. By interposing a tough film between the metal surface and water, Calgon definitely controls corrosion.

Calgon treatment of the water is particularly effective after mechanical main cleaning because of its fast film-forming ability. Protection for freshly scored metal surfaces is quickly built up and easily maintained. Calgon treatment is as inexpensive as it is effective — a few ppm control tuberculation and other corrosion problems as well.

A letter or phone call will bring you more information on how Calgon can help. Or, an experienced Calgon engineer will be glad to make detailed recommendations on your specific problem.

CALGON COMPANY

DIVISION OF HAGAN CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
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IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

†Fully licensed under U.S. Patent 2337856

(Continued from page 90 P&R)

process yielding 75 tons of chlorine and 80 tons of caustic soda.

Alabama Pipe Co. has commenced operations at its newly built multi-million-dollar plant at South Gate, Calif. Located on a 12-acre site a few miles southwest of Los Angeles, the plant will have an annual capacity of approximately 25,000 tons.

The USGS announces a number of personnel changes: Donald F. Dougherty has been appointed district engineer of the Albany, N.Y., area (Surface Water Branch), replacing Arthur W. Harrington, who recently retired. Elliott M. Cushing, formerly district geologist (Ground Water Branch), Memphis, Tenn., is now chief of the Mississippi Embayment Project at Memphis. D. S. Wallace has been named branch area chief (Surface Water Branch), Atlantic Coast States, with headquarters at Arlington, Va. W. R. Eaton has a similar assignment for the Midcontinent States, with headquarters at Chattanooga, Tenn.

B-I-F Industries, Inc., of Providence, R.I., has moved its Berkeley, Calif., office to 1766 Locust St., Walnut Creek, Calif. Headed by F. D. Brindel, district manager, the Walnut Creek office will sell and service the firm's extensive line of meters, feeders, and controls. The company has also opened a new branch office at Rocky Hill, in the Hartford, Conn., area. J. Richard Feibelman, formerly with the firm's Boston office, is in charge.

The St. Lawrence Seaway may be the cause of a water "shortage" in the Lake Michigan region. The lake currently serves as a source of supply for 8,000,000 people in 85 communities, but the commercial and industrial expansion due to completion of the seaway may result in a 25–50 per cent increase in the area's population. The consequent surge in water demand could pose grave problems for treatment plants with low-safety-factor capacities, according to a report presented at the recent AWWA Michigan and Wisconsin section meetings by Prof. Merrill B. Gamet, Northwestern Technological Institute, and John M. Rademacher, USPHS. The principal difficulty in enlarging treatment facilities may stem from adverse raw-water quality conditions, the study indicated.

As for raw-water quantity, this should present no problem. A US Lake Survey estimate made at low water in 1957 credited Lake Michigan with a volume of 1,170 *cubic miles* of water, or roughly 1,000,000,000,000,000 gal. The total Great Lakes water volume, incidentally, amounts to 5,442 cu mi, Lake Superior being in first place, of course, with 2,935 cu mi.

Employment Information

Classified ads will be accepted only for "Positions Available" or "Position Wanted." Rate: $1.50 per line (minimum $5.00), payable before publication. Deadline for ad copy: first of month prior to month of publication desired. To place ad, obtain "Classified Ad Authorization Form" from: Classified Ad Dept., Journal American Water Works Assn., 2 Park Ave., New York 16, N.Y.

Positions Available

WATER DISTRIBUTION SYSTEM ASSISTANT DISTRICT SUPERVISOR

Assists in supervising crews maintaining and repairing the City water distribution system. Requires four years experience, including one year as a supervisor, in installing and repairing water mains and appurtenances. Starting salary approximately $89 per week, regular increases, job stability, liberal fringe benefits. Send letter to Miss Alma Goldman, 975 City Hall, Philadelphia 7, Pennsylvania.

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From drawing board to final assembly . . . from precise mechanical tolerances to the clean lines of the pump itself . . . Precision's Model S chemical pump underscores exactness. It's just this exactness that assures the Model S's 24-hour dependability and extraordinary accuracy of solution delivery. Output rate may be regulated over the full range of 0 - 2.5 gph while the pump is in operation. A positive displacement, diaphragm type pump, the Model S is available in multiple heads for increasing capacity or for pumping different chemicals simultaneously. All materials contacting the chemical solution are plastic or synthetics capable of withstanding hypochlorite solutions. Even concentrated sulphuric acid may be pumped with a modification of the "S".

Models are engineered for automatic proportioning systems. Every pump is covered by a one year guarantee.

For further information, write Department 3A, Precision Chemical Pump Corporation, 1396 Main Street, Waltham 54, Massachusetts.

chlorination of water • chlorination of sewage
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PRECISION **CHEMICAL PUMP CORPORATION**

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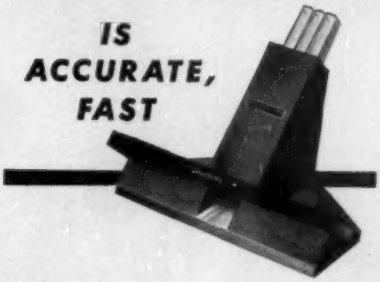
TESTING WATER?

The TAYLOR Water Analyzer

IS ACCURATE, FAST



Use for pH, color, ammonia, nitrites, chlorine, manganese, copper, fluoride, and total iron tests

In only minutes, the Taylor Water Analyzer gives you accurate determinations with on-the-spot colorimetric tests. Ideal for determining the pH of unbuffered or slightly buffered materials. All color standards are in easy-to-handle plastic slides to eliminate breakage problem.

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All Taylor liquid color standards carry an *unlimited guarantee against fading.* Be sure to use only Taylor Reagents and accessories with the Taylor Water Analyzer to assure accurate results.

SEE YOUR DEALER for Taylor sets or immediate replacement of supplies. Write direct for FREE HANDBOOK, "Modern pH and Chlorine Control". Gives theory and application of pH control. Illustrates and describes complete Taylor line.

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Service Lines

Sand and silt removal is accomplished by the new DorrClone Desanding System, available in five design combinations. The equipment is described in a 4-page, two-color bulletin, No. 2507, which can be obtained from the manufacturer, Dorr-Oliver, Inc., Stamford, Conn.

A recording turbidimeter has been developed for continuous monitoring of fluid turbidity or cloudiness. It is described in a 4-page illustrated brochure, Bulletin GET-2741-9, available from General Electric Co., Schenectady 5, N.Y.

Surface valves for filters are the subject of a new 4-page technical bulletin, which describes and illustrates the use of these controls for surface wash water applications and controlling the flow of water to filters. Copies of Bulletin W-17 may be obtained from the manufacturer, Golden-Anderson Valve Specialty Co., 1221 Ridge Ave., Pittsburgh 33, Pa.

Slotted-screen pipe is the subject of an illustrated, 8-page catalog, which discusses in detail the specifications and use of this equipment. The booklet is available from the manufacturer, Emsco Screen Pipe Co., Box 1446, Houston 21, Tex.

Gravimetric feeders for liquids or solids are illustrated and discussed in detail in a three-color, 8-page brochure. In addition to text and photographs, the publication provides dimensional drawings, tables, and performance charts relating to the equipment. Bulletin No. 32-R2 may be obtained from Omega Machine Co., division of B-I-F Industries, Inc., 345 Harris Ave., Providence 1, R.I.

Add to these benefits of

Cyanamid Alum

- Maximum adsorption of suspended and colloidal impurities
- Forms floc rapidly—coagulates in wide pH range
- Uniform feed—and a purity that minimizes equipment corrosion

The extra advantages of

Cyanamid Liquid Alum

- Easy unloading—no bags—compact storage—and turn-of-the-valve handling
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...and let Cyanamid help you with *technical service* based on long experience with dry and liquid alum installations. *Product service* from 9 shipping points, in bags, tank cars or tank trucks.

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One of two (2) main operating corridors showing individual filter control stations whose modern design permits initiating and carrying out the backwash cycle automatically.

CITY OF DETROIT

Department of Water Supply

NORTHEAST FILTER PLANT & PUMPING STATION

Gerald Remus, Dept. Gen. Mgr.

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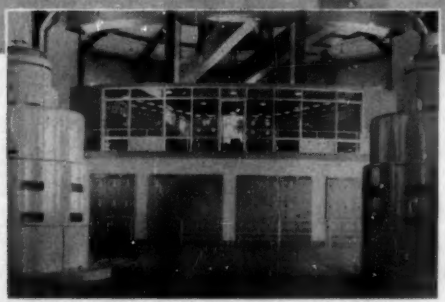

A view of the pump controls framed between two of the vertical motors. Enclosed control center contains all instrumentation necessary for monitoring operation of station. Large dial gauges provide continuous indication of station performance.

Plant engineer, George Dehem, inspects an individual filter control station with one of his filter attendants. All filter operation is supervised from this control panel.

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INTEGRATED EQUIPMENT OF PROVEN PERFORMANCE FROM "SINGLE RESPONSIBILITY" SOURCE!

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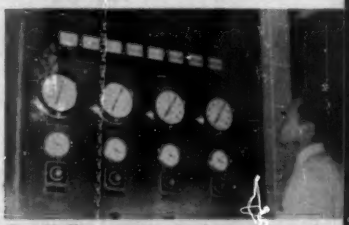
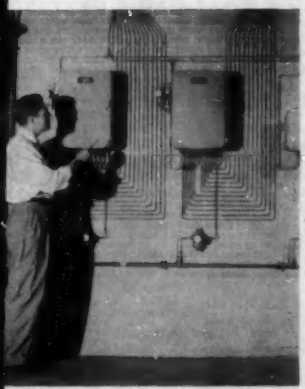
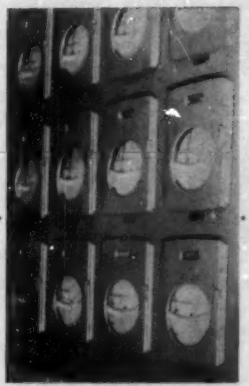


From this filter master control and annunciator panel, the flows through four batteries of twelve filters each can be observed and regulated to meet varying demands. Audible alarms and lights indicate any departure from desired conditions . . . allow operator to maintain optimum operation.



Each of these filter effluent flow summation units totalizes the flows through 12 individual filters and transmits a signal proportional to total flow to instruments located at key locations throughout the plant. In addition, the output of the four summation units is added to obtain total plant flow.



All plant functions for which permanent operating records are required are displayed on this central recorder panel thus permitting operating personnel to note trends of the various functions and departures from normal conditions.

One of the Omega Gravimetric feeders used for alum — others are used for activated carbon. These units provide reliable and accurate proportioning of chemicals to water being treated regardless of plant output variation.

NEW MEMBERS

Abbott, Wayne H., Jr., Distr. Engr., Board of Water & Light, 730 E. Hazel St., Lansing 3, Mich. (Oct. '58)

Aulicino, Alfred A., Water Supt., Munic. Bldg., Cedar Grove, N.J. (Jul. '58)

Baker, Louis N., Water Works Supt., Box 97, Port Richey, Fla. (Oct. '58)

Baker, William E., Water Supt., Utility Com., 237 N. Bluff St., St. George, Utah (Jul. '58)

Beard, Arthur H., Jr., Cons. Engr., 232 E. 6th St., Tucson, Ariz. (Oct. '58)

Bease-Johnson Co., J. Thomas Johnson Jr., Owner, 3030 Banksville Rd., Pittsburgh 16, Pa. (Assoc. M. Jul. '58)

Bell, Harry M., Supt., Water Works, College Corner, Ohio (Oct. '58)

Bluffton Munic. Utilities, N. W. Edington, Supt. of Utilities, Water Dept., City Bldg., 128 E. Market St., Bluffton, Ind. (Munic. Sv. Sub. Oct. '58)

Bonvouloir, Arthur H., Supt. of Public Works, 1430 Chicago Rd., Chicago Heights, Ill. (Oct. '58)

Bowman, Sherman W., Supt. of Filtration, Goffeyville, Kan. (Jul. '58)

Bredar, William L., Mgr., Colorado Office, Henningson, Durham & Richardson, 416 First National Bank Bldg., Colorado Spring, Colo. (Oct. '58)

Breedlove, Harold K., Water Foreman, Water Div., 125 E. College St., Covina, Calif. (Oct. '58)

Brock, William F., Sales Engr., Harwell Allen & Assocs., 207 Tuck Bldg., Nashville 3, Tenn. (Oct. '58)

Campbell, Owen T., Resident Salesman, Chase Brass & Copper Co., Inc., 137 E. Calhoun Ave., Memphis 2, Tenn. (Oct. '58)

Carney, Arvid, Supt. of Utilities, Whiteland, Ind. (Oct. '58)

Carr, Henry W., Supt., Munic. Water Works, St. John, Ind. (Oct. '58)

Carroll, James L., Gen. Mgr., Elk Grove Water & Sewer Co., Inc., 1 E. Higgins Rd., Elk Grove Village, Ill. (Oct. '58)

Chang, John Y. C., Civ. Engr., Water Dist. Div., Board of Water Supply, Box 3410, Honolulu 1, Hawaii (Oct. '58)

Christianson, Edward O. N., Dist. Mgr., Contra Costa County Water Dist., 2020 Railroad Ave., Pittsburg, Calif. (Oct. '58)

Chun, Raymond K., Civ. Engr., Hawaii Water Authority, Box 373, Honolulu 9, Hawaii (Oct. '58)

Clark, Charles E., Engr., Federal Electric Corp., 5th & Barrow, Anchorage, Alaska (Oct. '58)

Cockburn, Paul G., Student, Civ. Eng., Univ. of Toronto, 11 Minford Ave., Scarborough, Ont. (Jr. M. Oct. '58)

Coleman, Raymond C.; *see* Kirkham, Michael & Assoc.

Connor, Henry F., Branch Mgr., Worthington Corp., 305 W. Broadway, Louisville 2, Ky. (Oct. '58)

Daigle, George H., Rocket Valve Corp., 2829 E. 2nd Ave., Denver 6, Colo. (Oct. '58)

Dappert, Anselmo F., Exec. Secy., State Water Pollution Control Board, 84 Holland Ave., Albany 8, N.Y. (Oct. '42)

DeFranco, Frank J., Supt. of Filtration, Water Works, Weirton, W.Va. (Jul. '58)

DePue, Neil A., Water Supt., Water Works, 420 Idaho St., Gooding, Idaho (Oct. '58)

Dinn, Walter E., Planning Engr., Dept. of Water and Sewers, Box 316, Coconut Grove Station, Miami 33, Fla. (Oct. '58)

Dresden Utilities Com., C. W. King, Mgr., Main St., Dresden, Ont. (Munic. Sv. Sub. Jul. '58)

Dyer, Thomas H., Chairman, Onondaga County Water Authority, 1240 Wolf St., Syracuse, N.Y. (Jul. '58)

East Jordan Iron Works, Inc., F. Bruce Malpass, Sales Mgr., East Jordan, Mich. (Assoc. M. Jul. '58)

Eaton, George D., Sales Repr., Chapman Valve Mfg. Co., 233 Broadway, New York 7, N.Y. (Jul. '58)

Edgecomb, Fred, Operator, Plantation Water Treatment Plant, Utilities Operating Co., Plantation, Fort Lauderdale, Fla (Oct. '58)

Edington, N. W.; *see* Bluffton (Ind.) Munic. Utilities

Farber, Lawrence, Managing Editor, American Water Works Assn., 2 Park Ave., New York 16, N.Y. (Oct. '58)

Ferrero, Joseph Lewis, Environmental Health Trainee, Div. of San. Eng., State Health Dept., 300 Liberty Ave., Pittsburgh 22, Pa. (Jr. M. Oct. '58)

Feskoe, George J., Vice-Pres., Italit Inc., 620—5th Ave., New York, 19, N.Y. (Oct. '58)

Fitch, Gene, Owner, Gene Fitch Excavating Contractor, Hebron, Ohio (Oct. '58)

Fregeau, Jack J., Owner, Instrument Assocs., 7943 S. Exchange Ave., Chicago 17, Ill. (Oct. '58)

Gooding, City of, Fred W. Hendricksen, Councilman, Water Works Dept., 420 Idaho St., Gooding, Idaho (Munic. Sv. Sub. Oct. '58)

Hamina, Karl G., Salesman, Grand Rapids Loose Leaf Binder Co., 950 Monroe Ave., N.W., Grand Rapids 22, Mich. (Oct. '58)

Harbaugh, Robert R., Chief Engr., Water & Elec. Distr., Munic. Water & Elec. Plants, 127 E. 3rd St., Muscatine, Iowa (Jan. '57)

Harvey, James F., Engr., Mech. Div., C & C Constr. Co., Inc., 4625 Industrial Rd., Fort Wayne, Ind. (Oct. '58)

Hatt, Kenneth V.; *see* Hershey (Pa.) Water Co.

Hendricksen, Fred W.; *see* Gooding (Idaho)

Henke, Frank X., Jr., Sales Engr., Instrument Assocs., 9840 S. Hoyne Ave., Chicago 43, Ill. (Oct. '58)

Hershey Water Co., Kenneth V. Hatt, Asst. Comptroller, 9 W. Chocolate Ave., Hershey, Pa. (Corp. M., Oct. '58)

Holtzman, Henry, Partner, Holtzman Plumbing Contractor, 1414 Highland Ave., Chicago 26, Ill. (Oct. '58)

Hunt, R. H.; *see* Utah Construction Co.

Jacobs, Arthur Guyer, Jr., Elec. Pumping Plant Operator, Water Plant Operating Div., Dept. of Water and Power, 410 Ducommun St., Los Angeles 12, Calif. (Oct. '58)

Jacobucci, Paul J., Draftsman, Eng. Div., Board of Water Comrs., 144 W. Colfax Ave., Denver 2, Colo. (Oct. '58)

Jaffer, Robert P., Cons. Engr., Beeman, Britt, Curley & Jaffer, 3621B Henderson Blvd., Tampa 8, Fla. (Jul. '58)

Johnson, J. Thomas, Jr.; *see* Bease-Johnson Co.

Jolley, Lex, Vice-Pres., The Robinson-Humphrey Co. Inc., Box 1708, Atlanta 1, Ga. (Oct. '58)

King, C. W.; *see* Dresden (Ont.) Utilities Com.

Kirkham Michael & Assoc. Inc., Raymond C. Coleman, Secy.-Treas., 1104 Broadway, Fargo, N.D. (Corp. M. Oct. '58)

Kruscavage, Adam Edward, Water Plant Operator, Water Dept., 5040th Installation Group, Elmendorf Air Force Base, Anchorage, Alaska (Jul. '58)

Logeman, Albert E., Gen. Mgr., Peoples Water Light & Power Co., Main St., Mellen, Wis. (Oct. '58)

Lyons, John T.; *see* McComb (Miss.)

Malpass, F. Bruce; *see* East Jordan Iron Works

Mann, Phillip N., Secy.-Treas., Frabimor Equipment & Controls Co., Inc., 800 N. Clark St., Chicago 10, Ill. (Oct. '58)

Martin, Randolf M., City Engr., Eng. Dept., City Hall, 453 12th Ave., Vancouver 10, B.C. (Oct. '58)

McAvinchey, Patrick W., Civ. Engr., Ayres, Lewis, Norris & May, 500 Wolverine Bldg., Ann Arbor, Mich. (Oct. '58)

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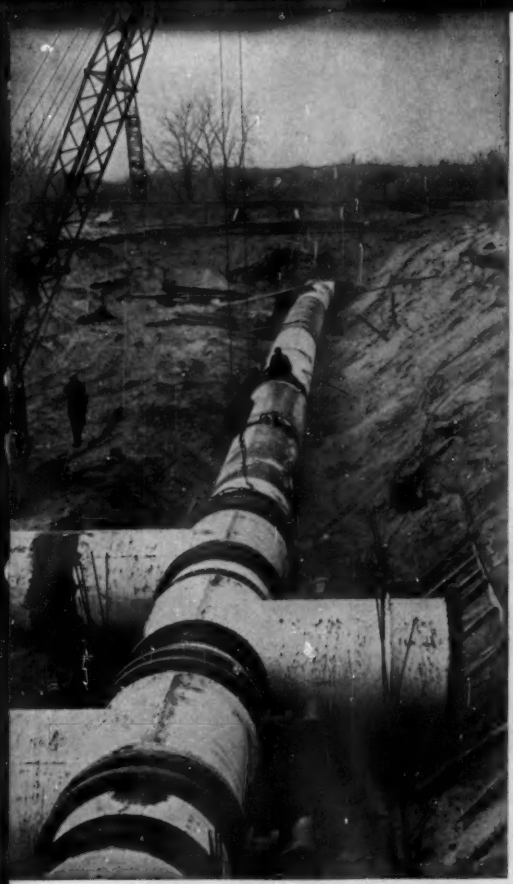

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McComb, Miss., City of, John T. Lyons, Chairman, Water & Sewer Committee, McComb, Miss. (Corp. M. Jul. '58)

McDermott, James Harry, Asst. San. Engr., U.S. Public Health Service, R. A. Taft San. Eng. Center, 4676 Columbia Pky., Cincinnati 26, Ohio (Oct. '58)

McMahan, Harold Clark; *see* Security (Colo.) Water Dist.

Meinert, Walter W., Ground Water Engr., C. S. Raymer Well Co., 1125 Covell Ave., N.W., Grand Rapids, Mich. (Oct. '58)

Miller, Eldon F., Mgr., Munic. Div., Graver Water Conditioning Co., 216 W. 14th St., New York, N.Y. (Jul. '58)

Miller, Lilian, Supt. of Water Works, Churubusco, Ind. (Oct. '58)

Moore, William M., Engr., Howard K. Bell, Cons. Engrs., 553 S. Limestone St., Lexington, Ky. (Oct. '58)

Morian, Louis D., Supt., Water Filtration Plant, 730 Osceola Ave., Big Rapids, Mich. (Oct. '58)

Murry, I. S. P., Gen. Mgr., East Niles Community Services Dist., 1417 Vale St., Bakersfield, Calif. (Oct. '58)

Nation, Oslin, Pres., Oslin Nation Co., 155 Pittsburg, Dallas 7, Tex. (Oct. '58)

Nefe, Kenneth F., Chief Operator, Water Works, 637 S. Main St., Frankenmuth, Mich. (Oct. '58)

Neubecker, Gerald F., Drilling Contractor, C. S. Raymer Co., 1125 Covell Rd., N.W., Grand Rapids 4, Mich. (Oct. '58)

Newell, Francis D., Operator, Water Filtration Plant, Deerfield, Mich. (Jul. '58)

O'Keefe, Robert J., Engr., C. & C. Constr. Co., Inc., 4625 Industrial Dr., Fort Wayne, Ind. (Oct. '58)

Okerlund, Orvis N., City Mgr., Manchester, Iowa (Oct. '58)

Orton, Alvin A., Supt., Water Dept., 711 Conn St., Council Grove, Kan. (Jul. '58)

Otero C., Francisco M., Chief Engr. & Mgr., Water Works, Box 275, Cienfuegos, Cuba (Jan. '58)

Pavlovich, John S., Jr., Chief Operator, Water Utility, 125 S. Mansfield St., Ironwood, Mich. (Oct. '58)

Postlethwaite, Robert C., Office & Field Engr., Denver Dist., Portland Cement Assn., 721 Boston Bldg., Denver 2, Colo. (Oct. '58)

Poulsen, George W., Jr., Cons. Engr., 402 Dooly Bldg., Salt Lake 1, Utah (Oct. '58)

Price, John T., Foreman, Board of Public Utilities, Box 257, Cheyenne, Wyo. (Oct. '58)

Quigley, B. M., Jr., Asst. Pumping Supervisor, Pumping Div., Water Works, 3630 Harry Hines Blvd., Dallas 19, Tex. (Jul. '58)

Raymer, Clifford Samuel, C. S. Raymer Co., Contractor Owner, 1125 Covell Rd., N.W., Grand Rapids 4, Mich. (Oct. '58)

Reinersman, Eugene J., Dist. Sales Repr., Kennedy Valve Mfg. Co., 36 Belle Monte Ave., South Fort Mitchell, Ky. (Oct. '58)

Reister, Elmer M., Supt. & Treatment Plant Operator, Water Works, College Corner, Ohio (Oct. '58)

Riebman, Saul H., Sales Engr., Simplex Valve & Meter Co., 7 E. Orange St., Lancaster, Pa. (Oct. '58)

Ring, John D., Supt., Water Works, Holland, Ind. (Oct. '58)

Roberts, Wyndham J., Engr., Eng. Sec., State Water Survey, Box 232, Urbana, Ill. (Oct. '58)

Roehrich, Fred J., Owner, Fred Roehrich Water Works Specialist, 14 Green Ave., Roseland, N.J. (Oct. '58)

Rogers, William J., Jr., San. Engr. Designer, Samuel L. Burns & Assocs., Inc., 428 Falls Bldg., Memphis, Tenn. (Oct. '58)

Rohaley, Donald Leo, Water Plant Worker, 5040th Air Installation, Elmendorf Air Force Base, Anchorage, Alaska (Jul. '58)

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Ross, Raymond W., Principal Clerk, New Business & Statistical Sec., Water Executive Div. Dept. of Water and Power, 207 S. Broadway, Rm. 707, Los Angeles 54, Calif. (Oct. '58)

Sebastian, Stanley Theodore, Water Engr., Water Services Dept., Box 231, Basseterre, St. Kitts, The West Indies (Oct. '58)

Security Water Dist., Harold Clark McMahan, Mgr., 223 Main St., Colorado Springs, Colo. (Corp. M. Oct. 58)

Shipman, Alvin E., Water Supt., Colorado Central Power Co., Evergreen, Colo. (Oct. '58)

Shone, John I., Director of Public Works, 227 S. Riverside Ave., Rialto, Calif. (Oct. '58)

Simmons, Loretta Blair, (Mrs.), Vice-Pres. & Treas., Blair Supply Corp., 244 Paul Rd., Rochester 11, N.Y. (Oct. '58)

Smales, John F., City Engr., 723 Railroad St., Elko, Nev. (Jul. '58)

Spall, William B., Salesman, Ulrich Chemical, Inc., 2640 W. Minnesota St., Box 7756, Indianapolis, Ind. (Jul. '58)

Stephens, Marvin E., Jr. Civ. Engr., Metropolitan Water Dist. of Southern Calif., 306 W. 3rd St., Los Angeles 13, Calif. (Oct. '58)

Stilwell, Norman R., Sales Engr., The Foxboro Co., 18240 W. Seven Mile Rd., Detroit 19, Mich. (Oct. '58)

Stone, Frances, Financial Consultant, 154–27 Willets Point Blvd., Whitestone 57, N.Y. (Oct. '58)

Sutliff, Emmett J., Chemist, Dept. of Water Works, 5941 Calumet Ave., Hammond, Ind. (Oct. '58)

Sutton, Stanley Hubert, San. Engr., Havens & Emerson, 640 Leader Bldg., Cleveland 14, Ohio (Oct. '58)

Swanson, Lloyd Herbert, Asst. Civ. Engr., Long Beach Water Dept., 403 Municipal Utilities Bldg., Long Beach 2, Calif. (Oct. '58)

Telsco Fittings Div., John Wilkinson, Sales Mgr., 5422 Redfield St., Dallas 35, Tex. (Assoc. M. Jul. '58)

Timmer, George W., Sales Engr., Frabimor Equipment and Controls Co. Inc., 800 N. Clark St., Chicago, Ill. (Oct. '58)

Tomlinson, C. C., Dist. Mgr., Southern Meter & Supply Co., 1300 W. Lee St., Greensboro, N.C. (Jul. '56)

Tufts, John N., Dist. Mgr., Chain Belt Co., 110—16th St., Denver 2, Colo. (Oct. '58)

Ungar, John, Scientific Officer, Industrial Waters Sec., Dept. of Mines & Technical Surveys, 40 Lydia St., Ottawa, Ont. (Oct. '58)

Utah Construction Co., Eng. Dept., Design Sec., R. H. Hunt, Chief Design Engr., 200 Hamilton Ave., Palo Alto, Calif. (Corp. M. Jul. '58)

Wallace, Edwin, Mgr., Utility Dept., Main St., Opp, Ala. (Oct. '58)

Waterman, M. C., Pres., Frabimor Equip. & Controls Co., Inc., 800 N. Clark St., Chicago 10, Ill. (Oct. '58)

Watts, C. Ralph, Asst. Supt., Calif. Water & Telephone, San. Marino, Calif. (Oct. '58)

Weiler, Daniel J., San. Engr., Navy Dept., 9th Dist. Public Works Office, Bldg. 1A, Great Lakes, Ill. (Jul. '58)

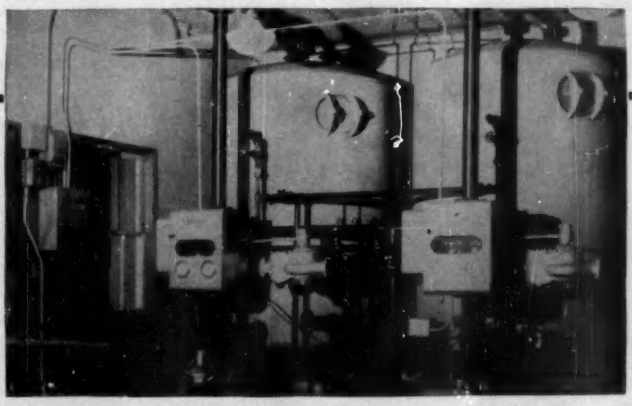
Westphal, Roy H., Supt., Water Dept., 30219 Adams Dr., Gibraltar, Mich. (Oct. '58)

Whitlock, Cleo C., Supt., Water & Sewer Dept., Box 60, Abilene, Tex. (Oct. '58)

Wilkinson, John; *see* Telsco Fittings Co.

Wilmarth, Gary W., Dist. Repr., Hersey Mfg. Co., 1557 Princeton Ave., Salt Lake 5, Utah (Oct. '58)

Woodside, Robert M., Sales Engr., Minneapolis Honeywell Regulator Co., 1900 Superior Ave., Cleveland 14, Ohio (Oct. '58)



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SALES OFFICES
New York City • Dallas
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Condensers:
Alco Products, Inc.
Allis-Chalmers Mfg. Co.
United States Pipe & Foundry Co.
Worthington Corp.

Contractors, Water Supply:
Layne & Bowler, Inc.

Controllers, Liquid Level, Rate of Flow:
Bailey Meter Co.
Builders-Providence, Inc. (Div., B-I-F Industries, Inc.)
Foxboro Co.
General Filter Co.
Simplex Valve & Meter Co.
Sparling Meter Co.

Copper Sheets:
American Brass Co.

Copper Sulfate:
General Chemical Div.
Tennessee Corp.

Corrosion Control:
Alco Products, Inc.
Calgon Co.
Industrial Chemicals, Inc.
Philadelphia Quartz Co.

Couplings, Flexible:
DeLaval Steam Turbine Co.
Dresser Mfg. Div.

Desalinization Plants:
Maxim Silencer Co.

Diaphragms, Pump:
Dorr-Oliver Inc.

Engineers and Chemists:
(See Professional Services)

Evaporating Equipment:
Maxim Silencer Co.

Feedwater Treatment:
Allis-Chalmers Mfg. Co.
Calgon Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Industrial Chemicals, Inc.
Permutit Co.
Proportioneers, Inc. (Div., B-I-F Industries, Inc.)

Ferric Sulfate:
Tennessee Corp.

Filter Materials:
Anthracite Equipment Corp.
Carborundum Co.
Dicalite Div.
General Filter Co.
Johns-Manville Corp.
Northern Gravel Co.
Permutit Co.
Stuart Corp.

Filters, Incl. Feedwater:
Dorr-Oliver Inc.
Graver Water Conditioning Co.
Permutit Co.
Proportioneers, Inc. (Div., B-I-F Industries, Inc.)
Roberts Filter Mfg. Co.
Ross Valve Mfg. Co.

Filtration Plant Equipment:
Builders-Providence, Inc. (Div., B-I-F Industries, Inc.)
Chain Belt Co.
Cochrane Corp.
Filtration Equipment Corp.
General Filter Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco Inc.
F. B. Leopold Co.
Omega Machine Co. (Div., B-I-F Industries, Inc.)
Permutit Co.
Roberts Filter Mfg. Co.
Simplex Valve & Meter Co.
Stuart Corp.
Wallace & Tiernan Inc.

Fittings, Copper Pipe:
Dresser Mfg. Div.
Hays Mfg. Co.
Mueller Co.

Fittings, Tees, Ells, etc.:
Alco Products, Inc.
American Cast Iron Pipe Co.
Cast Iron Pipe Research Assn.
James B. Clow & Sons
Dresser Mfg. Div.
M & H Valve & Fittings Co.
Morgan Steel Products, Inc.
Trinity Valley Iron & Steel Co.
United States Pipe & Foundry Co.
R. D. Wood Co.

Flocculating Equipment:
Chain Belt Co.
Dorr-Oliver Inc.
General Filter Co.
Graver Water Conditioning Co.
Infilco Inc.
F. B. Leopold Co.
Permutit Co.
Stuart Corp.

Fluoride Chemicals:
American Agricultural Chemical Co.
Tennessee Corp.

Fluoride Feeders:
Omega Machine Co. (Div., B-I-F Industries, Inc.)
Proportioneers, Inc. (Div., B-I-F Industries, Inc.)
Wallace & Tiernan Co., Inc.

Furnaces:
Jos. G. Pollard Co., Inc.

Gages, Liquid Level:
Bailey Meter Co.
Builders-Providence, Inc. (Div., B-I-F Industries, Inc.)
Burgess-Manning Co., Penn Instruments Div.
Simplex Valve & Meter Co.
Sparling Meter Co.
Wallace & Tiernan Inc.

Gages, Loss of Head, Pressure of Vacuum, Rate of Flow, Sand Expansion:
Bailey Meter Co.
Builders-Providence, Inc. (Div., B-I-F Industries, Inc.)
Burgess-Manning Co., Penn Instruments Div.
Foxboro Co.
Jos. G. Pollard Co., Inc.
Simplex Valve & Meter Co.
Wallace & Tiernan Inc.

Gasholders:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Graver Tank & Mfg. Co.
Hammond Iron Works
Pittsburgh-Des Moines Steel Co.

Gaskets, Rubber Packing:
James B. Clow & Sons
Johns-Manville Corp.

Gates, Shear and Sluice:
Armco Drainage & Metal Products, Inc.
Chapman Valve Mfg. Co.
James B. Clow & Sons
Mueller Co.
R. D. Wood Co.

Gears, Speed Reducing:
DeLaval Steam Turbine Co.
Worthington Corp.

Glass Standards—Colorimetric Analysis Equipment:
Klett Mfg. Co.
Wallace & Tiernan Inc.

Goosenecks (with or without Corporation Stops):
James B. Clow & Sons
Hays Mfg. Co.
Mueller Co.

Hydrants:
James B. Clow & Sons
Darling Valve & Mfg. Co.
M. Greenberg's Sons
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Hydrogen Ion Equipment:
W. A. Taylor & Co.
Wallace & Tiernan Inc.

Hypochlorite; see Calcium Hypochlorite; Sodium Hypochlorite

Ion Exchange Materials:
Allis-Chalmers Mfg. Co.
Cochrane Corp.
General Filter Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Permutit Co.
Roberts Filter Mfg. Co.

Iron, Pig:
Woodward Iron Co.

Iron Removal Plants:
American Well Works
Chain Belt Co.
Cochrane Corp.
General Filter Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.

Jointing Materials:
Johns-Manville Corp.
Keasbey & Mattison Co.
Leadite Co., Inc.

Joints, Mechanical, Pipe:
American Cast Iron Pipe Co.
Cast Iron Pipe Research Assn.
James B. Clow & Sons
Dresser Mfg. Div.
Trinity Valley Iron & Steel Co.
United States Pipe & Foundry Co.
R. D. Wood Co.

Leak Detectors:
Jos. G. Pollard Co., Inc.

Lime Slakers and Feeders:
Dorr-Oliver Inc.
General Filter Co.
Infilco Inc.
Omega Machine Co. (Div., B-I-F Industries, Inc.)
Permutit Co.
Wallace & Tiernan Inc.

Magnetic Dipping Needles:
W. S. Darley & Co.

Meter Boxes:
Ford Meter Box Co.
Pittsburgh Equitable Meter Div.

Meter Couplings and Yokes:
Badger Meter Mfg. Co.
Dresser Mfg. Div.

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All bronze
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Mueller Co.
Neptune Meter Co.
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Meter Testers:
Badger Meter Mfg. Co.
Ford Meter Box Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.

Meters, Domestic:
Badger Meter Mfg. Co.
Buffalo Meter Co.
Calmet Meter Div., Worthington Corp.
Gamon Meter Div., Worthington Corp.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.

Meters, Filtration Plant, Pumping Station, Transmission Line:
Bailey Meter Co.
Builders-Providence, Inc. (Div., B-I-F Industries, Inc.)
Burgess-Manning Co., Penn Instruments Div.
Foster Eng. Co.
Simplex Valve & Meter Co.
Sparling Meter Co.

Meters, Industrial, Commercial:
Badger Meter Mfg. Co.
Bailey Meter Co.
Buffalo Meter Co.
Builders-Providence, Inc. (Div., B-I-F Industries, Inc.)
Burgess-Manning Co., Penn Instruments Div.
Calmet Meter Div., Worthington Corp.
Gamon Meter Div., Worthington Corp.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
Simplex Valve & Meter Co.
Sparling Meter Co.

Mixing Equipment:
Chain Belt Co.
General Filter Co.
F. B. Leopold Co.

Paints:
Inertol Co., Inc.
Koppers Co., Inc.
Plastics & Coal Chemicals Div.

Pipe, Asbestos-Cement:
Johns-Manville Corp.
Keasbey & Mattison Co.

Pipe, Brass:
American Brass Co.

Pipe, Cast Iron (and Fittings):
Alabama Pipe Co.
American Cast Iron Pipe Co.
Cast Iron Pipe Research Assn.
James B. Clow & Sons
Trinity Valley Iron & Steel Co.
United States Pipe & Foundry Co.
R. D. Wood Co.

Pipe, Cement Lined:
American Cast Iron Pipe Co.
Cast Iron Pipe Research Assn.
James B. Clow & Sons
United States Pipe & Foundry Co.
R. D. Wood Co.

Pipe, Concrete:
American Concrete Pressure Pipe Assn.
American Pipe & Construction Co.
Lock Joint Pipe Co.
Vulcan Materials Co.

Pipe, Copper:
American Brass Co.

Pipe, Steel:
Alco Products, Inc.
Armco Drainage & Metal Products, Inc.
Bethlehem Steel Co.
Morgan Steel Products, Inc.

Pipe Cleaning Services:
National Water Main Cleaning Co.

Pipe Coatings and Linings:
American Cast Iron Pipe Co.
Cast Iron Pipe Research Assn.
Centriline Corp.
Inertol Co., Inc.
Koppers Co., Inc.
Plastics & Coal Chemicals Div.
Reilly Tar & Chemical Corp.

Pipe Cutters:
James B. Clow & Sons
Ellis & Ford Mfg. Co.
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.

Pipe Jointing Materials; see Jointing Materials

Pipe Locators:
W. S. Darley & Co.
Jos. G. Pollard Co., Inc.

Plugs, Removable:
James B. Clow & Sons
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.

Potassium Permanganate:
Carus Chemical Co.

Pressure Regulators:
Allis-Chalmers Mfg. Co.
Foster Eng. Co.
Golden-Anderson Valve Specialty Co.
Mueller Co.
Ross Valve Mfg. Co.

Pumps, Boiler Feed:
Allis-Chalmers Mfg. Co.
DeLaval Steam Turbine Co.

Pumps, Centrifugal:
Allis-Chalmers Mfg. Co.
American Well Works
DeLaval Steam Turbine Co.
Peerless Pump Div.
C. H. Wheeler Mfg. Co.

Pumps, Chemical Feed:
Precision Chemical Pump Corp.
Proportioneers, Inc. (Div., B-I-F Industries, Inc.)
Wallace & Tiernan Inc.

Pumps, Deep Well:
American Well Works
Layne & Bowler, Inc.
Peerless Pump Div.

Pumps, Diaphragm:
Dorr-Oliver Inc.
W. S. Rockwell Co.
Wallace & Tiernan Inc.

Pumps, Hydrant:
W. S. Darley & Co.
Jos. G. Pollard Co., Inc.

Pumps, Hydraulic Booster:
Peerless Pump Div.
Ross Valve Mfg. Co.

Pumps, Sewage:
Allis-Chalmers Mfg. Co.
DeLaval Steam Turbine Co.
Peerless Pump Div.
C. H. Wheeler Mfg. Co.

Pumps, Sump:
DeLaval Steam Turbine Co.
Peerless Pump Div.
C. H. Wheeler Mfg. Co.

Pumps, Turbine:
DeLaval Steam Turbine Co.
Fiese & Firstenberger
Layne & Bowler, Inc.
Peerless Pump Div.

Recorders, Gas Density, CO_2, NH_3, SO_2, etc.:
Permutit Co.
Wallace & Tiernan Inc.

Recording Instruments:
Bailey Meter Co.
Builders-Providence, Inc. (Div., B-I-F Industries, Inc.)
Burgess-Manning Co., Penn Instruments Div.
Simplex Valve & Meter Co.
Sparling Meter Co.
Wallace & Tiernan Inc.

Reservoirs, Steel:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Graver Tank & Mfg. Co.
Hammond Iron Works
Pittsburgh-Des Moines Steel Co.

Sand Expansion Gages; see Gages

Sleeves: see Clamps

Sleeves and Valves, Tapping:
James B. Clow & Sons
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.

Sludge Blanket Equipment:
Cochrane Corp.
General Filter Co.
Graver Water Conditioning Co.
Permutit Co.

Sodium Chloride:
International Salt Co., Inc.

Sodium Fluoride:
American Agricultural Chemical Co.

Sodium Hexametaphosphate:
Calgon Co.

Sodium Hypochlorite:
John Wiley Jones Co.
Wallace & Tiernan Inc.

Sodium Silicate:
Philadelphia Quartz Co.

Sodium Silicofluoride:
American Agricultural Chemical Co.
Tennessee Corp.

Softeners:
Cochrane Corp.
Dorr-Oliver Inc.
General Filter Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.

Softening Chemicals and Compounds:
Calgon Co.
General Filter Co.
Industrial Chemicals, Inc.
International Salt Co., Inc.
Permutit Co.
Tennessee Corp.

Standpipes, Steel:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Graver Tank & Mfg. Co.

CORPORATION STOPS...

It Pays to Buy HAYS

High quality water service bronze, 85-5-5-5 mix . . .
Plugs individually ground in for perfect fit . . .
Corporation stops can be installed with any standard tapping machine . . .
Threads interchangeable with those of other manufacturers . . .
Conform to all A.W.W.A. standards.

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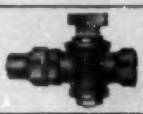
DUO-STOP CORPORATION STOP and SADDLE COMBINED



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HAYS MANUFACTURING CO.
ERIE, PA.

Hammond Iron Works
Pittsburgh-Des Moines Steel Co.

Steel Plate Construction:
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Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Graver Tank & Mfg. Co.
Hammond Iron Works
Morgan Steel Products, Inc.
Pittsburgh-Des Moines Steel Co.

Stops, Curb and Corporation:
Hays Mfg. Co.
Mueller Co.

Storage Tanks: see Tanks

Strainers, Suction:
James B. Clow & Sons
R. D. Wood Co.

Surface Wash Equipment:
Permutit Co.

Swimming Pool Sterilization:
Builders-Providence, Inc. (Div., B-I-F Industries, Inc.)
Omega Machine Co. (Div., B-I-F Industries, Inc.)
Proportioneers, Inc. (Div., B-I-F Industries, Inc.)
Wallace & Tiernan Inc.

Tanks, Steel:
Alco Products, Inc.
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Graver Tank & Mfg. Co.
Hammond Iron Works
Morgan Steel Products, Inc.
Pittsburgh-Des Moines Steel Co.

Tapping-Drilling Machines:
Hays Mfg. Co.
Mueller Co.
A. P. Smith Mfg. Co.

Tapping Machines, Corp.:
Hays Mfg. Co.
Mueller Co.

Taste and Odor Removal:
Builders-Providence, Inc. (Div., B-I-F Industries, Inc.)
General Filter Co.
Graver Water Conditioning Co.
Industrial Chemical Sales Div.
Permutit Co.
Proportioneers, Inc. (Div., B-I-F Industries, Inc.)
Wallace & Tiernan Inc.

Turbidimetric Apparatus (For Turbidity and Sulfate Determinations):
Wallace & Tiernan Inc.

Turbines, Steam:
Allis-Chalmers Mfg. Co.
DeLaval Steam Turbine Co.

Turbines, Water:
Allis-Chalmers Mfg. Co.
DeLaval Steam Turbine Co.

Valve Boxes:
James B. Clow & Sons
Ford Meter Box Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
A. P. Smith Mfg. Co.
Trinity Valley Iron & Steel Co.
R. D. Wood Co.

Valve-Inserting Machines:
Mueller Co.
A. P. Smith Mfg. Co.

Valves, Altitude:
Golden-Anderson Valve Specialty Co.
W. S. Rockwell Co.
Ross Valve Mfg. Co., Inc.
S. Morgan Smith Co.

Valves, Butterfly, Check, Flap, Foot, Hose, Mud and Plug:
Builders-Providence, Inc. (Div., B-I-F Industries, Inc.)
Chapman Valve Mfg. Co.
James B. Clow & Sons
DeZurik Corp.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
Henry Pratt Co.
W. S. Rockwell Co.
S. Morgan Smith Co.
R. D. Wood Co.

Valves, Detector Check:
Hersey Mfg. Co.

Valves, Electrically Operated:
Builders-Providence, Inc. (Div., B-I-F Industries, Inc.)
Chapman Valve Mfg. Co.
James B. Clow & Sons
Darling Valve & Mfg. Co.
DeZurik Corp.
Golden-Anderson Valve Specialty Co.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
Henry Pratt Co.
W. S. Rockwell Co.
A. P. Smith Mfg. Co.
S. Morgan Smith Co.

Valves, Float:
James B. Clow & Sons
Golden-Anderson Valve Specialty Co.
Henry Pratt Co.
W. S. Rockwell Co.
Ross Valve Mfg. Co., Inc.

Valves, Gate:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Darling Valve & Mfg. Co.
DeZurik Corp.
Dresser Mfg. Div.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
W. S. Rockwell Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Hydraulically Operated:
Builders-Providence, Inc. (Div., B-I-F Industries, Inc.)
Chapman Valve Mfg. Co.
James B. Clow & Sons
Darling Valve & Mfg. Co.
DeZurik Corp.
Golden-Anderson Valve Specialty Co.
Kennedy Valve Mfg. Co.
F. B. Leopold Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
Henry Pratt Co.
W. S. Rockwell Co.
A. P. Smith Mfg. Co.
S. Morgan Smith Co.
R. D. Wood Co.

Valves, Large Diameter:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Darling Valve & Mfg. Co.
Golden-Anderson Valve Specialty Co.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
Henry Pratt Co.
W. S. Rockwell Co.
A. P. Smith Mfg. Co.
S. Morgan Smith Co.
R. D. Wood Co.

Valves, Regulating:
DeZurik Corp.
Foster Eng. Co.
Golden-Anderson Valve Specialty Co.
Mueller Co.
Henry Pratt Co.
W. S. Rockwell Co.
Ross Valve Mfg. Co.
S. Morgan Smith Co.

Valves, Swing Check:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Darling Valve & Mfg. Co.
Golden-Anderson Valve Specialty Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
W. S. Rockwell Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Venturi Tubes:
Builders-Providence, Inc. (Div., B-I-F Industries, Inc.)
Burgess-Manning Co., Penn Instruments Div.
Simplex Valve & Meter Co.

Waterproofing:
Inertol Co., Inc.
Koppers Co., Inc.
Plastics & Coal Chemicals Div.

Water Softening Plants; see Softeners

Water Supply Contractors:
Layne & Bowler, Inc.

Water Testing Apparatus:
LaMotte Chem. Products Co.
W. A. Taylor & Co.
Wallace & Tiernan Inc.

Water Treatment Plants:
American Well Works
Chain Belt Co.
Chicago Bridge & Iron Co.
Dorr-Oliver Inc.
General Filter Co.
Graver Water Conditioning Co.
Hammond Iron Works
Hungerford & Terry, Inc.
Infilco Inc.
Permutit Co.
Pittsburgh-Des Moines Steel Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.
Wallace & Tiernan Inc.

Well Drilling Contractors:
Layne & Bowler, Inc.

Wrenches, Ratchet:
Dresser Mfg. Div.

Zeolite: see Ion Exchange Materials

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BASIC CHEMICALS FOR WATER
look to General Chemical!

Here's why . . .

As a leading supplier of alum and other basic chemicals for water treatment, General Chemical has the large-scale production facilities, the coast-to-coast network of supply points, and the long background of experience that you need. Technical service is readily available – without obligation–to municipal water officials who want help with operating and technical problems. Look to General for your chemical requirements.

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Aluminum Sulfate, Standard
Aluminum Sulfate, Liquid
Ammonium Alum
Potassium (Potash) Alum
Sodium Silicate

FLUORIDATION
Sodium Fluoride
Sodium Silicofluoride
Hydrofluoric Acid

DECHLORINATION
Sodium Sulfite
Sodium Bisulfite, Anhy.
Sodium Thiosulfate

BOILER WATER
Sodium Sulfate, Anhy.
Disodium Phosphate, Anhy.
Trisodium Phosphate
Sodium Silicate
Sulfuric Acid

CORROSION CONTROL
Sodium Silicate
Tetrasodium Pyrophosphate
Sodium Tripolyphosphate

OTHER USES
Aqua Ammonia
Hydrochloric Acid (Muriatic)
Baker & Adamson® Laboratory Reagents and Fine Chemicals

Basic Chemicals for American Industry

Allied Chemical

GENERAL CHEMICAL DIVISION
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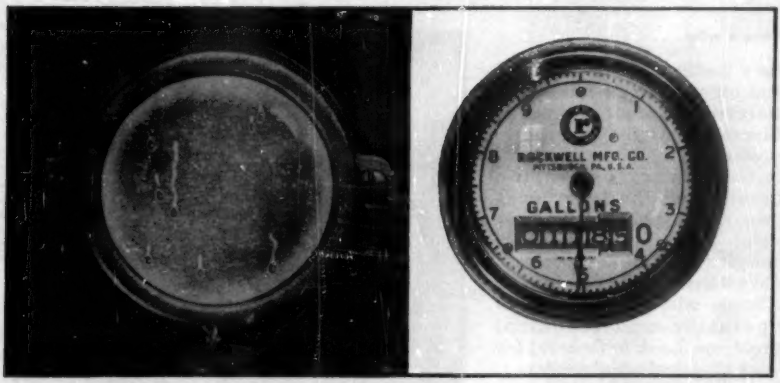
What good is a meter if you can't read it?



DIRTY FACE

Condensation and dirt cloud the dial on this conventional register.

CLEAN FACE

Rockwell hermetically sealed register always presents a "clean face" to the meter reader.

YOU CAN ALWAYS READ A ROCKWELL SEALED REGISTER WATER METER

In recent years water utilities have spent thousands for oil enclosures, wipers and similar gadgets to lick the problem of fogged registers. Now, for not a penny extra, Rockwell offers a revolutionary new meter having a hermetically sealed register which completely eliminates condensation under the glass.

In the Rockwell Sealed Register meter all gearing, including the intermediate train, is encased in a sealed compartment high and dry above the measuring chamber. There's no stuffing box to leak or bind. A powerful magnetic coupling transmits motion smoothly and with the least possible friction. All this means less wear, less chance for corrosive attack, and, of course, easier maintenance at lower cost. Get full facts now, *write to Rockwell Manufacturing Company, Pittsburgh 8, Pa.*

SEALED REGISTER METERS

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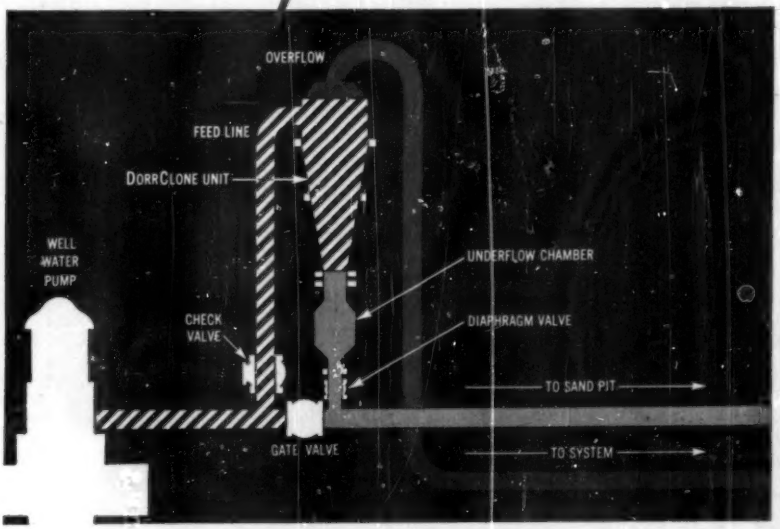

THE DORRCLONE WELL WATER DESANDING SYSTEM

Continuous, positive removal of practically all undesirable sand and silt—without use of any power other than pressure supplied by the pump! That's what you get with the new DorrClone desanding system! It's today's simplest, lowest cost, most practical method of desanding well water—pays for itself over and over by reducing sanded mains, excessive wear and plugging of meters and abrasion of appliances.

Heart of the system is the DorrClone unit, a cylindroconical shell, shown diagrammatically above. In operation, raw feed water enters tangentially under pressure at the top. A vortex action is created, throwing sand particles to the walls of the cone and down to the underflow at the bottom. Sand-free water at the center of the vortex flows out the top to storage, a treatment plant, or directly to the mains.

Units may be designed to suit practically all well water systems. For full information, write for a copy of Bulletin No. 2507.

DorrClone, T.M. Reg. U.S. Pat. Off.

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LEADITE

Jointed for . . . Permanence with LEADITE

Generally speaking, most Water Mains are buried beneath the Earth's surface, to be forgotten,—they are to a large extent, laid for permanency. Not only must the pipe itself be dependable and long lived,—but the joints also must be tight, flexible, and long lived,—else leaky joints are apt to cause the great expense of digging up well-paved streets, beautiful parks and estates, etc.

Thus the "jointing material" used for bell and spigot Water Mains MUST BE GOOD,—MUST BE DEPENDABLE,—and that is just why so many Engineers, Water Works Men and Contractors aim to PLAY ABSOLUTELY SAFE, by specifying and using LEADITE.

Time has proven that LEADITE not only makes a tight durable joint,—but that it improves with age.

The pioneer self-caulking material for c. i. pipe.
Tested and used for over 40 years.
Saves at least 75%

THE LEADITE COMPANY
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